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How to Develop Personalized eHealth for Behavioural Change: Method & Example

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Preface

In the current health care landscape, patients are more than ever expected to take an active approach in managing their condition. For patients with chronic conditions this means that they have to change their behaviour and develop new routines to deal with the day-to-day care of their disease. eHealth applications via websites or smartphone apps can offer essential support for these patients. Information and communication in these applications should match users' needs and abilities. This report focuses on how such personalized eHealth applications to support behavioural change can be developed in an evidence-based and incremental approach.

Following a situated Cognitive Engineering method, we will formulate the demands and requirements for personalized eHealth support and will identify socio-cognitive factors for personalizing information and communication. We will operationalize these theoretical insights into the design of a prototype personalized behavioural change support system and test this prototype with its design rationale in a feasibility study with prospective users of such systems.

The research in this report has been carried out as part of the ZonMW (Dutch Organisation for Health Research and Development) programme Diseasemanagement for Chronic Illness, project Periscope (*Personalized and Contextualized Information in Self-Management Systems for Chronically Ill Patients;* projectnumber 300020001) from February 2010 to February 2014. The project is a collaboration between the Leiden University Medical Center and TNO, Netherlands.

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Summary

Self-managing your health and the complications and risks of chronic conditions need to be supported by care professionals and self-management support systems (SMSS). An SMSS is a computer system which helps patients to control the risks of his condition and maintain his health. Mostly, a change in life style and health behaviour is necessary, and it is exactly this change that only the person himself can achieve.

In the Periscope project we have investigated which requirements an SMSS should meet to support users in changing their life style with a personalized SMSS and how this support can be developed and tested in a systematic manner. We have chosen to investigate this in the domain of changing dietary habits, as this is an important factor to maintain health and prevent risks in many chronic conditions (e.g. diabetes and renal diseases).

We know from the literature that form and content of information needs to be matched to rational ('conscious') as well as affective ('unconscious') information processing of the users of SMSS. This means that information needs to correspond to users' personal situation, appreciations, motivation and cognitive capacities. The Periscope project has investigated how information in SMSS can take into account these personal factors, how this information should be designed and whether it is feasible to measure personal factors and determine the form of personalized information utulizing a prototype SMSS.

The result of this research is a method that utilizes insights from previous research from the scientific literature, and user experiences and requirements to offer tailored information in SMSS. The developed method has been tested and evaluated by conducting an experiment with participants that have a chronic kidney condition who have to watch their diet very carefully using a prototype containing tailored messages. From this experiment we have concluded that interaction design patterns for tailored information can be applied in SMSS aimed at patients with chronic kidney conditions. One of the preconditions for implementing tailored information is that SMSS can reliably measure user characteristics and how users use the SMSS. Instruments that can measure this easy and reliable are being developed. The Periscope project has made an important step towards personalized information, but further research remains necessary into interaction design patterns for personalized information and the operationalization of theoretical insights into practical SMSS.

Contents

1 Introduction

1.1 Behavioural change support in health care

The current health care landscape in The Netherlands is characterized by an aging population and rising prevalence of chronic conditions on the demand side of care, while health care providers are faced with austerity measures and the consequent need for greater efficiency (Dutch Council for Public Health and Health Care, 2010; Dutch Council for Publich Health and Health Care, 2010). One of the main approaches in future healthcare therefore is a greater emphasis on patients' own responsibility and ability to take over care actions from providers, i.e. self-management (Wagner et al., 2001; Bodenheimer, Wagner, & Grumbach, 2002b). These chronic conditions are for an important part life style dependent, and require patients to change their behaviour and incorporate new routines in their life style. Thus, patients have a personal responsibility to take an active role in their care process, although this does not mean that patients are on their own in coping with their condition (Newman, Steed, & Mulligan, 2004). Several educational programs to help patients learn to self-manage and change their behaviour to cope with their condition have been developed. eHealth[1] solutions like websites and mobile phone applications are also being developed to support patients in self-management by providing educational materials and guidance to change and maintain healthy life styles in accordance with their condition (Portnoy, Scott-Sheldon, Johnson, & Carey, 2008; Sarasohn-Kahn, 2013). We refer throughout the report to these systems as behavioural change support (BCS) and self-management support systems (SMSS). This report will focus on the role of such eHealth systems to offer support for people who can benefit greatly from life style changes and developing tailored self-management support systems that accommodate personal preferences and skills of users.

The use of SMSS to support patients to change their behaviour has to date lead to moderate success. Two key challenges have arisen during the past years. The first challenge is to address the complexity of communication that results from using SMSS (Te'eni, 2001). Patients are much more on their own and have less direct feedback from professional caregivers when using such systems. Information that is communicated to patients by means of SMSS is aimed at increasing patients' knowledge of their condition and persuade them to change their life style to accommodate their disease. While information in SMSS, together with professional caregivers and patients' social environment, can support patients to change their life style, patients have to make these changes themselves. It is therefore paramount to make sure that patients understand information and are convinced to take actions to stabilize or even improve their health. An important consideration in this regard is that there are differences between people in the way they process information and are triggered to change their behaviour. These cognitive differences need to be taken into account when communicating with patients via SMSS.

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[1] eHealth has been defined by Eysenbach (2001) as: *"[…] the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and realted technologies. […] a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care […] by using information and communication technology."*

Tailoring information to the distinctive circumstances and abilities of individual patients provides a means to account for these differences and thus improve the effectiveness of self-management support systems for behavioural change (Hawkins, Kreuter, Resnicow, Fishbein, & Dijkstra, 2008). However, tailoring to date has seen a focus on relatively broad concepts to determine which information needs to be communicated to which person. In this report we will advocate for a more dynamic and sensitive form of tailoring which takes into account people's personal situation, appreciations, motivation and cognitive abilities to realize truly personalized information. In Chapters 4 and 8 we will further elaborate on these tailoring techniques.

The second challenge concerns the development of eHealth based behavioural change support. The development of SMSS has been rather ad-hoc and aimed at supporting specific patient groups. A more methodological, user centered development would be preferable to provide evidence based and incremental development of such systems and that takes advantage of proven insights and solutions. By not focusing on specific clinical conditions, we aim to provide solutions that are not bound to one specific domain, but can be reused and adapted for different clinical conditions. This development should not be driven only from a medical perspective, but needs to take user requirements into account (Gustafson & Wyatt, 2004; Pal et al., 2013). Below we will present a methodology for evidence-based and incremental development of such support systems. This report will describe this methodology and show its applicability in the (e-)health care domain.

1.2 Aim and Research Questions

The aim of this report is twofold. First, we will investigate which requirements SMSS must meet to support users to change their life style and how this personalized support can be designed and tested in a systematic manner. These requirements will be based on insights from previous research from the domains of self-management and behavioural change. Second, we will investigate whether the proposed methodology (see paragraph 1.3) offers a suitable framework for evidence-based and incremental design of SMSS functionalities and whether claims that are derived from previous research can be adapted to the self-management domain and can be validated in an online prototype.

The research questions that follow from these aims are:

- How can SMSS take the personal factors of users into account when communicating health information?
- How should this personalized information look like?
- Can the effectiveness of this personalized information be tested in online SMSS?

1.3 Methodology: situated Cognitive Engineering

The research reported in this report has been guided by a situated Cognitive Engineering approach. Situated Cognitive Engineering (sCE) has been developed at TNO and Delft University of Technology by professor Mark Neerincx and colleagues and aims to provide a theoretical and empirical driven user-centered design methodology for ICT based socio-cognitive support (Neerincx & Lindenberg, 2008; Neerincx, 2011). This methodology aims specifically at translating theoretical insights into the design of functionalities for support (i.e. a design dilemma), as opposed to for instance the Intervention Mapping approach (see e.g. Kok, Schaalma, Ruiter, Van Empelen, & Brug, 2004), which focuses on selecting and testing the proper technology for support (i.e. a selection dilemma)[2].

Situated Cognitive Engineering advocates an incremental and iterative development process in three phases. The methodology is incremental as it builds on proven theories and developed functionality can be reused in future development processes. It is iterative as it promotes insights that have been developed in one of the phases to be used to adjust and refine insights from the other phases.

The sCE process (see Figure 1.1) starts with a Work Domain and Support Analysis (WDS). The WDS incorporates a specification of the operational demands, i.e. which task(s) the system should support, socio-cognitive theories that play a role in these tasks, and what technology is envisioned to be able to support these tasks.

Based on the WDS, Core Functions (CF) that describe the specific functionalities that are needed to realize the operational demands need to be specified. Each CF should be accompanied by Claims on its operational effects, including possible positive and negative outcomes, to justify the incorporation of said CF, in favor of other functionality that could realize the same operational demands. Not always enough supporting evidence for the Claims can be derived from previous research, and in these instances, Claims should serve as hypotheses to be validated in the next phase of sCE (Refinement). To illustrate and organize the CF, Use Cases can be used. For clarity, these Use Cases need to refer to the CF and Claims they support, and can be incorporated in a scenario to present and discuss their rationale with stakeholders. Furthermore, they provide a means for incremental development: in future systems where comparable Use Cases exist, previously developed CF can be reused. To describe the shape of CF (i.e. what does the CF look like) Interaction Design Patterns should be specified. Interaction Design Patterns offer a structured description of the design of CF and include how it looks, in which context the design can be used and what rationale is behind the design. The CF and accompanying Use Cases, Interaction Design Patterns and Claims are part of the Requirements Baseline (RB) for the support system in development and serve as rationale and justification of these requirements.

The third phase of sCE concerns the refinement and validation of the RB. This is an incremental and iterative process including review of the RB by prospective users and experts and prototype testing the functionality specified in the RB. By using prototypes, Claims concerning the operational effects of functionality can be validated in a real life situation.

This report serves as an example of the application of sCE in the health care domain. More extensive descriptions and examples of sCE from the space, defense and educational domains have been published, e.g. Neerincx (2011), Neerincx et al. (2008) and Peeters, Van Den Bosch, Meyer, and Neerincx (2012).

[2] The two approaches (sCE and IM) are as such complementary and a project aiming at combining both approaches is currently being developed at TNO, The Netherlands.

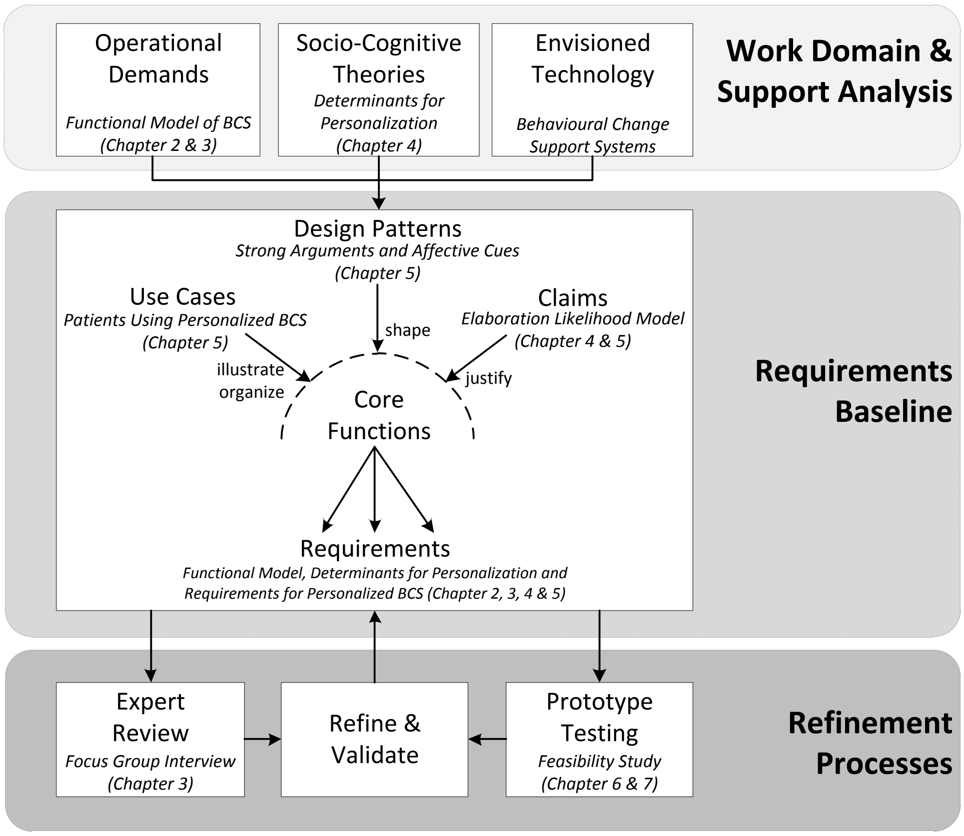

Figure 1.1 Situated Cognitive Engineering methodology. Italicized titles show how each step is embedded in this report.

1.4 Contents of chapters

In this report, we focus on eHealth as a technology to support people who are at risk for or have a chronic illness who can benefit from a change in their life style. First, we will determine in general which functionalities are needed to offer tailored support to users in managing their health and life style. These operational demands for these systems are described in Chapters 2 and 3. Both chapters focus on the question of what an SMSS should look like to provide tailored self-management support. Chapter 2 bases demands from a medical and scientific perspective on a literature study and provides a first instantiation of a requirements baseline by providing a functional model of behavioural change support by SMSS. Chapter 3 refines these demands in a qualitative study with prospective users of SMSS. To establish which personal factors can be utilized to offer personalized support with such system, we will address relevant socio-cognitive theoretical models from behavioural change and communication in Chapter 4. Chapters 2, 3 and 4 as such form the Work Domain and Support Analysis, and address the first research question posed in paragraph 1.2.

Chapter 5 will report on the specification of an RB describing personalized behavioural change support based on the Elaboration Likelihood Model of Persuasion (ELM; Petty & Cacioppo, 1986). Claims that justify the use of different Core Functions for specific users to match their cognitive abilities and motivations, and use cases that describe the context in which these CFs are used, are provided in this chapter. Chapter 5 also describes the design patterns that shape these personalized Core Functions. This chapter hence addresses the second research question concerning how personalized information in SMSS should look like.

We will continue with describing the Refinement Processes in the subsequent chapters. In Chapter 6 we describe a controlled experiment to show the feasibility of the personalized Core Functions that we have proposed. We have illustrated our RB with a scenario and several general use cases describing the context in which such personaized CF could be used, which are provided in Appendices A and B. Chapter 7 addresses a feasibility study to investigate the proposed personalized functionality. Both chapters concern the third research question of using an online SMSS to test the feasibility of the specified Requirements Baseline, and Chapter 6 offers additional insight in the research question concerning how personalized information should look like by instantiating Design Patterns into persuasive messages for SMSS.

We will end in chapter 8 with the conclusions and recommendations for future development we can draw from our investigation into personalized information for BCS.

To sum up, we will first formulate demands and requirements for tailored SMSS from socio-cognitive theories, medical literature and insights from prospective users of such systems. Second, we will investigate which socio-cognitive factors can be used to personalize information in SMSS. Third, we will show how to operationalize theoretical insights into practical requirements for personalized SMSS. The latter is done through systematically formulating and validating design patterns and claims concerning personalized persuasive information. We will conclude the report by summarizing what the key requirements for personalized BCS are, which socio-cognitive factors can be used to personalize information in BCS and how these socio-cognitive factors can be operationalized in personalized BCS.

2 Functional Model of Behavioural Change Support[3]

Summary

In this chapter we provide an overview of critical success factors for self-management and the implication of these for the key functionalities and processes in self-management support systems for behavioural change, based on key articles from the literature on patient empowerment and self-management. These functionalities and processes address the Operational Demands for a comprehensive SMSS from a medical and scientific point of view. By means of discussions with professional caregivers and patients, the key functionalities and processes were further refined and organized in a functional model for behavioural change support. The model can encourage users' understanding of self-management systems, assessment of existing systems and requirements engineering for new and existing systems and the interoperability with other healthcare-related systems. In Chapter 3, the operational demands from prospective users' point of view will be investigated. The results from Chapter 3 were used to refine the model. Subsequent chapters will build upon this functional model in developing the requirements for tailored SMSS.

[3] This chapter has been published and presented as:

Laverman, M., Schonk, J.H.M., Boog, P.J.M. van der, & Neerincx, M.A. (2010). Personalized and contextualized information in self-management systems for chronically ill patients (PERISCOPE). *Proceedings of the European Conference on Cognitive Ergonomics*. Delft: Delft University of Technology.

Laverman, M., Alpay, L.L., Neerincx, M.A., & Schonk, J.H.M. (2011). The development of a requirements baseline for tailored self-management systems. *Proceedings of the 5th Human Factors Engineering in Health Informatics Symposium*. Trondheim, Norway: Tapir Academic Press.

2.1 Need for evidence-based development of behavioural change support

The number of chronically ill patients is expected to increase considerably in the next fifteen to twenty years (World Health Organization, 2005; Blokstra & Verschuren, 2007; Dutch Council for Public Health and Health Care, 2010; United Nations Development Programme, 2010). In addition, investments and workforce in healthcare are not expected to keep up with this development during this period (World Health Organization, 2006; Dutch Council for Publich Health and Health Care, 2010). As a result, a gap between demand and delivery of healthcare is anticipated and there is great concern whether the healthcare sector will be able to cope with this disparity. It is therefore imperative to consider alternative healthcare approaches.

Self-management is regarded as one of the key approaches in future healthcare for chronically ill patients (Wagner et al., 2001; Bodenheimer et al., 2002b). It is believed that self-management has a twofold impact. First, it is beneficiary to the workload of healthcare professionals, as some of their tasks are taken over by patients. Second, self-management is expected to have a positive impact on the prevalence of complications of chronic conditions by changing life style (Michalsen, König, & Thimme, 1998; Marks, Allegrante, & Lorig, 2005; Riegel et al., 2009).

Self-management is a broad concept. The WHO (1984) has defined self-management as:

“[...] the activities individuals, families and communities undertake with the intention of enhancing health, preventing disease, limiting illness, and restoring health. These activities are derived from knowledge and skills from the pool of both professionals and lay experience. They are undertaken by lay people on their own behalf, either separately or in participative collaboration with professionals.”

More recently, scholars have defined self-management in a similar fashion (Barlow, Wright, Sheasby, Turner, & Hainsworth, 2002; Bodenheimer, Lorig, Holman, & Grumbach, 2002a; Schermer, 2009; Blanson Henkemans, Alpay, & Dumay, 2010). In practice self-management includes a range of activities, from regularly taking physiological measurements (e.g. blood glucose, weight and blood pressure) and sending these data to a healthcare professional who can decide on a treatment plan, to patients who fully manage their disease and change their life style accordingly. These latter patients have learned to set their own goals and to monitor and evaluate their progress towards achieving these goals, and thus to enhance their quality of life (Clark et al., 1991; Barlow et al., 2002; Lorig & Holman, 2003; Newman et al., 2004; Schermer, 2009). Presently, self-management programmes and research increasingly take into account the social context of patients; not only patients themselves are engaged in self-management, but living with a chronic disease also has an impact on their relationship with family, friends and work (Grey, Knafl, & McCorkle, 2006; Ryan & Sawin, 2009).

Although the degree of self-management can vary between patients as well as conditions, it always requires patients to take an active and participative role in their care process, taking responsibility for the day-to-day care of their illness and managing their lifestyle and health (Newman et al., 2004; Schermer, 2009). For effective self-management, it is necessary that patients increase their knowledge about their condition, acquire competencies to cope with their condition, receive sufficient support and have appropriate tools (Barlow et al., 2002; Lorig & Holman, 2003; Newman et al., 2004; Lawn & Schoo, 2010).

In the Netherlands, the urgent need for self-management is reflected in an ongoing range of initiatives by governmental bodies (Central Accompagnement Organization, 2009) and via patient organisations (Federation of Patients and Consumer Organisations in the Netherlands, 2009). These initiatives show a general trend towards a change of focus from ‘Illness and Care’ to ‘Health and Behaviour’ (Dutch Council for Public Health and Health Care, 2010). Patient empowerment is regarded as a means of promoting self-management. Patient empowerment enhances the capacity of patients to access health information and make effective choices. Subsequently, it increases patients’ capacity to transform these choices into desired actions and outcomes (Peterson, 2001; Funnell & Anderson, 2004; Aujoulat, D'Hoore, & Deccache, 2007; Blanson Henkemans et al., 2010).

In recent years, various self-management interventions have been initiated and evaluated for a wide range of chronic diseases, including amongst others asthma, chronic heart failure, diabetes, renal diseases and chronic pain conditions (Brug, Oenema, Kroeze, & Raat, 2005; Kroeze, Werkman, & Brug, 2006; Williams, 2011; Labre, Herman, Dumitru, Valenzuela, & Cechman, 2012; Steinsbekk, Rygg, Lisulo, Rise, & Fretheim, 2012; Pal et al., 2013). Consequently, the literature on self-management to date offers many factors that are critical for successful self-management. Due to advances in Information and Communication Technology (ICT), an increasing number of these self-management interventions include an ICT mediated self-management support system (SMSS) as a supportive tool (Portnoy et al., 2008; Lustria, Cortese, Noar, & Glueckauf, 2009; Schermer, 2009; Alpay, Blanson Henkemans, Otten, Rövekamp, & Dumay, 2010; Bosworth, Powers, & Oddone, 2010). Furthermore, patients themselves are also increasingly interested in and willing to use ICT support to manage their condition (Sarasohn-Kahn, 2013). However, the development of these systems seems rather ad hoc, without taking into account experiences from previously developed systems or systems developed and used in the treatment of other conditions (Gustafson & Wyatt, 2004; Williams, 2011). Furthermore, the development of these systems is seldom based on literature and, consequently, the theoretical basis of these systems is limited or even lacking (see also Bodenheimer et al., 2002a; Chodosh et al., 2005). As a consequence, a framework in which the basic requirements for ICT mediated SMSS are made explicit is lacking (Pal et al., 2013). In this chapter we propose such a framework of key functionalities and processes, which is grounded in the current literature on self-management, self-management interventions and systems. We propose this framework not as a blueprint of how SMSS de facto should look like, but as guidance to aid the improvement of SMSS in terms of effectiveness and impact on self-management behaviours and health outcomes. In the discussion, we will further elaborate on the role of the framework in the domain of tailored ICT mediated SMSS.

2.2 Method: Literature search

In order to identify the key processes, theories and technologies that play a role in self-management, we searched the Pubmed database (http://www.ncbi.nlm.nih.gov/pubmed/) for English articles (including reviews) from the past decade (2000-2010), with the key words ‘patient empowerment’, ‘self-management’, ‘self-care’, ‘self-management intervention’, ‘self-management system’, ‘self-management application’ and ‘review’ (n = 152). Our goal was to search for the critical success factors (i.e. factors related to effectively enabling and promoting self-management for patients) for the operational demands regarding SMSS. Based on title and abstract, we selected articles that mentioned at least one critical success factor. When title and abstract were unclear, we scanned the text of these articles to determine if they mention at least one critical success factor. We did not distinguish between types of illness but restricted the search to articles considering chronic, non-mental illnesses within adult patients.

The selected publications (n = 50) were read by three authors (ML, LA and BS) with expertise in health care, self-management and eHealth. These three authors made consensus about the critical success factors for SMSS by means of face-to-face discussions. From these critical success factors, we derived activities and information that should be part of an SMSS. In the next step we identified the key components of SMSS that can support these activities and facilitate information supply (i.e. the operational demands for the envisioned technology). It is clear that not all self-management activities are suitable for ICT mediated support, and alternatives such as face-to-face contact should be considered.

Our literature search resulted in an ordering of key components and a global description of the functionalities and contents of these components, as a first specification of the requirements baseline. This was used in separate face-to-face discussions with professional caregivers (one nephrologist and one dietist) from the nephrology department of the Leiden University Medical Centre (LUMC), patients (n = 2) and researchers (n = 2) in the field of self-management and eHealth from the LUMC and TNO Expertise Centre Life Style (Leiden, The Netherlands). Furthermore, results from a later focus group interview with patients with a chronic kidney disease (n = 8) were used to refine the requirements baseline. The focus group and its results are reported in Chapter 3 of this report.

Based on these discussions, the requirements were refined and adjusted (see also Figure 1.1). For instance, in the first specification we did not include functionality for users to keep personal notes and a first concise ‘personal information’ component was extended to a more comprehensive user model containing also parameters that can be used for tailoring information in the system (see Results for a further elaboration). Furthermore, the discussions led to the organization of the requirements into a high-level framework describing the functional components and the processes that are supported by these components.

2.3 Critical success factors of support systems for behavioural change

Patients engaged in self-management need to perform a number of tasks to deal with the daily activities and events that are common for their condition. In 2003, Lorig and Holman presented a model which currently is widely used as a reference among self-management researchers. We therefore organize the critical success factors in the section below according to the tasks that patients have to undertake when self-managing their condition as proposed by Lorig, namely: medical management; role management; and emotional management (Lorig & Holman, 2003). We will complement this with the results from the literature search and discussions.

Medical management, according to Lorig, involves tasks that patients have to perform as part of the medical treatment plan prescribed by their professional caregiver (Lorig & Holman, 2003; Funnell & Anderson, 2004). This includes amongst others taking medication and adhering to a specific diet. Medical management tasks are in their most basic form merely the directives given by professional caregivers, which are based on standard, evidence based treatment protocols (Funnell & Anderson, 2004). In this situation, patients follow the directives given by their professional caregiver without adapting these directives to their personal situation. For example, they may adhere to their medication as originally prescribed. Even in this basic case, a SMSS can play a role: directives can be imported into a SMSS, which can provide reminders for taking medication or measurements. This entails that SMSS should contain a calendar-function and a function to store the directives in the form of a care plan (Polonsky et al., 2010). It is additionally possible to monitor compliance with the care plan, if the patient also registers his medication regimen in the SMSS.

However, some directives are broader than Lorig suggests, and need to be embedded into the daily activities of a patient, for example when patients are advised to change their sodium intake to control hypertension. These directives need to be tailored to patients' specific situations and habits. Patients can individually decide on how to adjust their daily sodium intake, or by mutual agreement with their professional caregiver. They can thus adapt general directives based on what they find important for a good quality of life. In this case, a convergence of Lorig's medical management and role management is clearly discernible.

In Lorig and Holman's model, role management entails "maintaining, changing and creating meaningful behaviours and life roles" (Lorig & Holman, 2003). This implies that patients have to adjust their daily activities in order to cope with their illness, symptoms and impairments. They need to change their life style (e.g. eating habits, daily tasks and exercise) in order to prevent complications and reduce the symptoms of their condition. Role management entails that patients decide on their personal objectives in cooperation with their professional caregiver (Barlow et al., 2002; Funnell & Anderson, 2004; Lawn & Schoo, 2010).

Regarding the example of sodium intake reduction that was introduced above, patients need to keep track of their daily diet and gain insight into their dietary habits and intake. This information can then be used to set their personal goals and to make a plan for reducing their sodium intake. During this process, feedback from professional caregivers or automated feedback from the SMSS can help patients and keep them motivated (Chodosh et al., 2005; Blanson Henkemans, 2009; Damush et al., 2010; Newcomb, McGrath, Covington, Lazarus, & Janson, 2010; Nundy, Dick, Solomon, & Peek, 2013). SMSS can support this process by providing functionality to keep track of patients' goals and plans and functionality to register self-measurements related to those goals (Ceriello et al., 2012). Patients and caregivers are thus able to monitor the progress towards achieving the goals. The

SMSS should provide a communication function for interaction between patients and caregivers, for instance in order to give feedback on patients' progress.

Some patients can manage their health problems in a fully autonomous manner. In order to do so, they need to identify their health problems and set specific, measurable, action oriented, realistic, and timely (SMART) goals. The progress towards these goals has to be monitored and evaluated (Barlow et al., 2002; Hill-Briggs, 2003; Funnell & Anderson, 2004; Coleman & Newton, 2005; Maes & Karoly, 2005; Bodenheimer & Handley, 2009; Lawn & Schoo, 2010; van der Meer et al., 2010; Ceriello et al., 2012). To be able to perform these tasks and understand possible choices and consequences, patients should increase their knowledge of their condition and the impact of life style decisions. They should also acquire essential skills (including goal setting and self-measuring) to cope with their condition (Barlow et al., 2002; Bodenheimer et al., 2002a; Funnell & Anderson, 2004; Sigurdardóttir, 2005; DiMatteo, Haskard, & Williams, 2007; Lawn & Schoo, 2010). This knowledge can also be obtained from experiences of fellow patients or e-learning, for instance by watching video clips or playing serious games (Baranowski, Buday, Thompson, & Baranowski, 2008; DeShazo, Harris, & Pratt, 2010). Consequently, SMSS should provide functionality to keep track of patients' health problems and relate SMART goals and plans to these problems. Additionally, based on monitoring of self-measurements, SMSS should be able to evaluate progress towards these goals. Furthermore, SMSS should provide information about disease, health and skills in a manner patients can understand and thus encourage empowerment (Hamnes, Hauge, Kjeken, & Hagen, 2011).

When a patient is using an SMSS independently, it is necessary for the information in the system to be tailored to the specific situation and characteristics of the patient, to facilitate understanding of the information and to prevent overwhelming the patient (Gustafson & Wyatt, 2004; Noar, Benac, & Harris, 2007; Lustria et al., 2009). Furthermore, tailoring can enhance the interaction with systems to meet patient's mental model, which has a significant influence on perceived usability (Roberts, Berry, Isensee, & Mullaly, 1997). In order to be able to provide patient specific information, SMSS need to store characteristics of patients (e.g. condition, treatment plans, medication, cognitive characteristics) by means of a patient profile, or user model (De Vries & Brug, 1999; Fischer, 2001). In Chapter 4 we will further elaborate on tailoring and which characteristics can be used to tailor information in SMSS.

The third task of self-management according to Lorig and colleagues is emotional management (Lorig & Holman, 2003). This involves dealing with emotions that are commonly experienced by chronic patients, such as anger, fear, frustration and depression. These emotions have an impact on self-management behaviours (Barlow et al., 2002; Sigurdardóttir, 2005). Emotional management can in part also be supported by SMSS, particularly by means of a platform to communicate with caregivers or fellow patients (Coleman & Newton, 2005). This can also utilize motivational interviewing and emotional support strategies (e.g. Wagner & Ingersoll, 2008; DiMarco, Klein, Clark, & Wilson, 2009).

Next to the increasing participation of patients in their own care process and in addition to Lorig and Holman's model, the influence of 'social management' (Barlow et al., 2002; Newman et al., 2004) has increasingly been recognized. Several studies have demonstrated that advice and feedback from peers is effective for managing symptoms, healthy behaviour and hospital visits (Gallant, Spitze, &

Prohaska, 2007; Lorig et al., 2008; Hughes, Wood, & Smith, 2009; Strom & Egede, 2012; Gagliardino et al., 2013). In addition, there has been a rising acknowledgement that patients are not alone in dealing with their condition. Informal caregivers like family and friends, and patients' employment are also influenced by their chronic condition (Clark, 2003; Grey et al., 2006; Ryan & Sawin, 2009; Funnell, 2010; Hamnes et al., 2011). Advances in technology make it continually easier to get and keep in touch with other patients. An SMSS should therefore facilitate communication between patients and their caregivers, other patients and their social network. Members of the care- or social network should have the ability to provide advice or feedback to patients and patients should have the ability to store this advice or feedback as notes in a personal database, which can also be used to store favourites (e.g. websites, recipes, walking routes) and share information and experiences with peers.

In addition to the success factors discussed above, the literature provides a number of prior conditions that facilitate self-management. Since these prior conditions do not affect the design of SMSS, we will not elaborate on these here. Nevertheless, it is worth pointing out that self-management is increasingly being adopted by healthcare policy makers and medical insurance companies (e.g. the inclusion of self-management in care standards for chronic diseases by Dutch Diabetes Federation, 2007; Platform Vitale Vaten, 2009; Dutch Lung Alliance, 2010; Dutch Obesity Partnership, 2010), a policy which is influenced by both patient organisations and financial cutbacks. Patient organisations emphasise the importance of developing knowledge and skills, participation, communication between patients and professionals and other patients' experiences (Central Accompagnement Organization, 2009; Federation of Patients and Consumer Organisations in the Netherlands, 2009). The focus of these healthcare policy reports is primarily on the growing use of social networks on the internet for information exchange and consequently the shift from expertise and authority of the 'traditional' healthcare system to the adoption of wisdom of the crowd (Federation of Patients and Consumer Organisations in the Netherlands, 2009; Dutch Council for Public Health and Health Care, 2010; Dutch Council for Publich Health and Health Care, 2010; Frissen, 2010; Gerads, Hooghiemstra, Arnold, & Van Der Heide, 2010). Furthermore, a great deal of attention is given to the organizational, legal and financial changes healthcare is facing today (Gerads et al., 2010).

2.4 Functional model of support systems for behavioural change

The main challenge for chronically ill patients is to learn to cope and live with their disease, and to adopt a healthy life style to prevent worsening of their condition whilst maintaining an acceptable quality of life for themselves and their intimate social network (Hamnes et al., 2011). In this regard, they are essentially continuously engaged in adjusting their life style to their health problems. Particularly in the first period after diagnosis, patients have to learn how to cope with their problems and how they can control and prevent symptoms and complications. Lorig and Holman (2003) have also acknowledged this and they have consequently proposed problem solving as one of the core self-management skills. The activities within SMSS should be aimed at facilitating this process. Therefore, the core of the framework we propose represents this process as a problem-solving cycle inspired by the PDCA (plan-do-check-act) process proposed by Deming (Shewhart, 1939; Deming, 1994). Additionally, this problem-solving cycle is supported by two complementary levels: information and additional functions (see Figure 2.1). Below, we will first discuss the core process of the framework and then the complementary levels. We will provide an example of how a patient can use such an SMSS in his daily life by introducing Bob (a full scenario of a patient using an SMSS can be found in Appendix A [in Dutch]). Bob is a 58-year old patient with a chronic kidney disease (CKD) and he needs to keep his blood pressure under control to stabilize his kidney function. His physician has suggested to use an SMSS to help him control his blood pressure.

The core problem solving process starts with the identification of the problems that a chronically ill patient faces and wants to resolve in order to minimize the risk of complications and to maintain his quality of life. This can be accomplished in cooperation with a professional or an informal caregiver, or independently using information about their disease or experiences of fellow patients. This results in a personal problem list, which can be used to prioritize these problems.

When Bob was diagnosed with a CKD, his physician explained to him what this would mean for his daily life and that he should change his diet. However, the diagnosis was quite a shock for him, so he couldn't remember much of his physician's advice when he got home. Bob uses the SMSS to find information about diet for CKD, and he learns that a lowering your salt intake can help lower your blood pressure and stabilize the kidney function. He's not sure if he uses too much salt, but he remembers his physician telling him to start watching his salt intake. He therefore selects 'salt intake' as a problem to solve.

After the key problems have been identified, SMART-formulated goals in relation to the specific problems should be set. Additionally, a step-by-step plan on how to reach this goal in a specified time frame can be formulated. These goals and plans can be prioritized and a care plan can be derived from this. This care plan can be used as a basis for monitoring, evaluating and providing feedback in relation to the specified goals.

When Bob has selected 'salt intake' as a problem, the SMSS advises him to set a goal. Bob has read that a maximum of 6 grams of salt a day is advised for a healthy life style, so he sets this as his goal. He is not completely sure which parts of his diet contain the most salt. He decides to first take a week to find out which parts he needs to replace and then try a week to reach his goal. So he selects a date two weeks from now to attain his goal of 6 grams of salt a day.

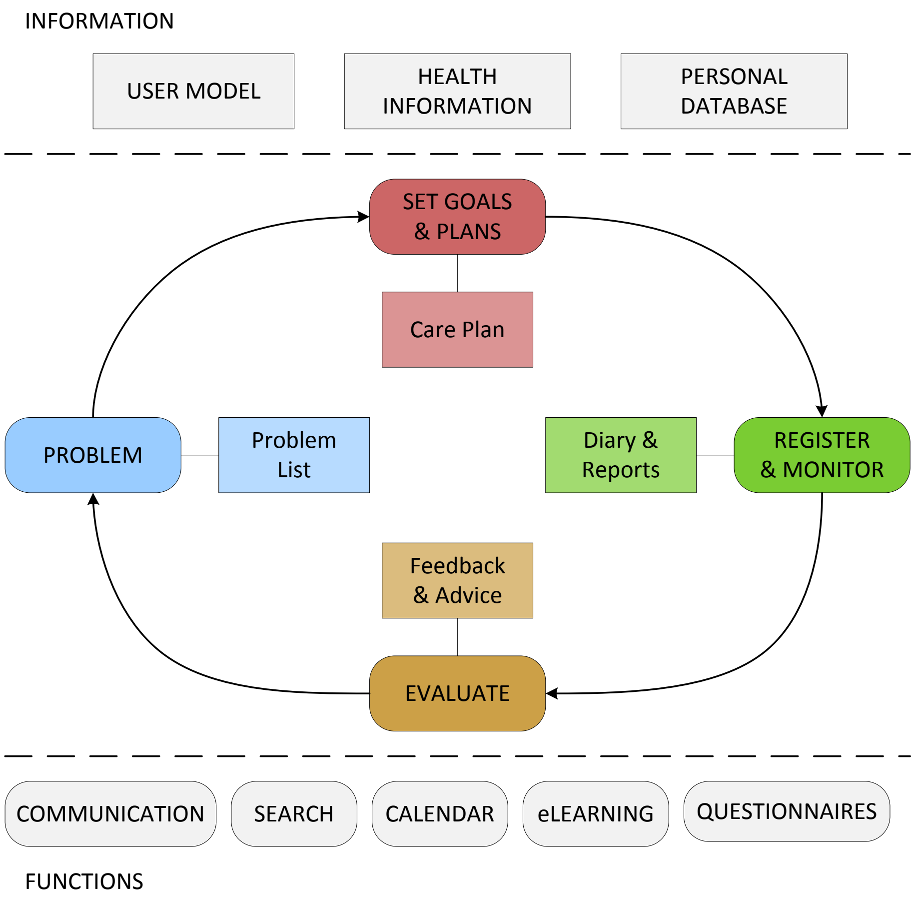

Figure 2.1 Functional model of supporting behavioural change by SMSS

In the process of pursuing their health goals, patients can monitor the progress they are making. Specifically, an SMSS should provide a diary in which patients can record all health related activities they carry out, such as dietary information, medication, exercise, physiological and psychological measures. Using this diary, the patient will be able to obtain an overview of the history of these activities and measurements in the form of reports and charts.

The SMSS that Bob is using contains a database with nutritional values of a wide range of food products. Every day he uses this database to select what he has consumed that day. The system gives him feedback on how much salt he has consumed every day and the salt content of each product. This way, he can quickly see which products contain much salt.

The subsequent and last step of the problem-solving cycle is to evaluate the progress that was made towards achieving a specific goal. This evaluation can be performed autonomously, by manually or automatically comparing recorded measures or activities to specific goals, or in cooperation with one of the caregivers.

Both the caregiver and the SMSS can provide feedback or advice about the progress during this step.

After two weeks, the system reminds Bob that he has to evaluate his progress. A chart shows him his daily salt intake for the last two weeks, and a report tells him which products he uses contain the highest salt content. Bob found that he did not quite reach is goal, some days he did, but other days he was still above 6 grams of salt a day. Some products were easy to replace, such as that pizza every Friday, but other products he has to find an alternative for. He is so used to eating bread with cheese and cut meat every breakfast and lunch, and he is not sure how he can replace these. Bob decides to take this report the next time he visits the dietician at the hospital to consider alternatives.

The above description shows the process in its complete form. In practice, it is not always necessary to go through all the steps. For instance, for some tasks (e.g. monitoring medication adherence) formulating problems or goals is not obligatory, and it would be sufficient to keep a diary and evaluate this periodically. It depends on both the individual patient and the specific condition which steps will be most important. When developing tailored SMSS using the sCE methodology, this needs to be addressed in the operational demands and requirements of the support system.

The core process is facilitated by the two supporting levels (information and functions). The respective aims of these levels are to 1) provide information for both the system and the patient, and 2) provide generic functionality that supports the core self-management process.

The information level includes three components: User Model, Health Information and Personal Database. The User Model contains a user (patient) profile with user related characteristics (e.g. age, dietary preferences, cognitive capabilities), which can be viewed and adjusted by the patient. These parameters are used to identify the user and tailor the contents and information within the system to the patient's specific situation and abilities (see also Chapter 4). In the Health Information component, all health-related information is stored. The user can browse and query this information. The information can be used for decision-support in each of the steps of the core process. The Personal Database is meant for personal storage of personal information. In this component, the user can store for instance personal notes (e.g. in relation to feedback and advice) and favourites (e.g. links to websites, recipes, or exercises) and share these with authorized other users of the system.

To facilitate the core problem-solving process, several additional generic functions are required. In the model these are presented in the functions level. To be able to communicate with professional or informal caregivers and fellow patients, as well as providing reminders or alarms, the system needs a communication function. This function should provide internal (user to user, system to user) or external (reminders and alarms via e-mail or sms) messages. A search function is needed to search health-related (from the Health Information component in the system or from external sources on the internet) and manually entered (e.g. self-measurements from a specific period, favourites or a specific goal or plan) information. Most activities that the patient has to undertake are time-related, such as regularly taking medication, the time frame for reaching a goal or hospital appointments. SMSS need a calendar function to keep track of this information and to be able to send notifications of alarms when needed. To be able to successfully perform self-management, it is very important that patients learn certain skills (see also Lorig & Holman, 2003; Alpay, Van der Boog, & Dumay, 2011). SMSS should therefore contain a skills building function to enable patients to acquire these skills. This function can take the form of an e-learning module in which patients can learn the necessary skills for their personal situation (Reis, McGinty, & Jones, 2003; Chou, Lin, Woung, & Tsai, 2010). This function contains basic, practical information for learning skills, and patients can check which skills they possess and which ones they still have to learn. Not all skills can be acquired through e-learning, some need to be acquired in a different context (e.g. communication skills). Finally, it should be possible to present questionnaires to users of the system. Questionnaires have a twofold purpose. First, they can be used to gather information about the user for use in the user model (including evaluating health literacy and skills). Second, they may be used to evaluate usability and involve users in the development of the system.

2.5 Conclusion & Discussion

In this chapter we have presented a functional model, which incorporates the core functionalities, information and processes that play a role in SMSS, informed by literature on self-management. The model addresses the operational demands of SMSS and presents the required set of functional components for a comprehensive SMSS and its design rationale. The presented model provides a first instantiation of the requirements baseline, and as such serves as a basis for an iterative process of refinement of the identified functionalities and processes.

The functional model can serve as a framework in the engineering process for developing new and existing SMSS. In this process, the framework can be utilized in three roles:

1. Role in requirements engineering
   Comparable to how we use the model in this report; the model can play a role in engineering requirements for new systems, as well as the improvement of existing SMSS. It can serve as a basis from which functional requirements are formulated and can help keep track of relations between functionalities. Furthermore, by providing a uniform conceptual model, it can aid collaboration and mutual understanding between stakeholders (patients, healthcare professionals, designers, insurance companies, see e.g. Gustafson & Wyatt, 2004; Alpay et al., 2011; Blanson Henkemans et al., 2013).
2. Reference for assessment of existing healthcare systems
   The model can serve as a reference for existing systems to assess to what extent functionality to support self-management is provided (compare e.g. Health Level Seven's EHR/PHR System Functional Model (2008) and Blanson Henkemans et al. (2013)). This data can be used to determine which role a system can play in self-management, and functionality that can be integrated in different systems aimed at supporting self-management.

3. Tool to help users understand self-management support systems
   The model can play an important role to support users (patients as well as healthcare professionals) when using SMSS by explaining the organization of the system, the self-management process and tasks. This model can be incorporated into the design and presentation of the system to provide support to users. Especially in more comprehensive SMSS, users can lose track of where they are in the system. For instance, because components can be used in different tasks (e.g. the problem list can be used while setting a goal, but also while evaluating progress towards solving a specific problem).

The addition of the user model and functionality for administering questionnaires is essential to be able to tailor information to individual users. Questionnaires are required for measuring the determining socio-cognitive factors for tailoring. These measurements in turn have to be stored in the user model. The user model acts as a database or profile of the distinctive circumstances and (cognitive) abilities of individual users from which the tailoring strategies can be determined (see also Fischer, 2001; Arnrich, Mayora, Bardram, & Troster, 2010). The utilization of user models in healthcare related systems to fully automatically tailor information has not received much attention, despite its importance for tailoring (Doupi & van der Lei, 2002; Franklin, Waller, Pagliari, & Greene, 2003; Wang & Liu, 2005; Jibaja-Weiss & Volk, 2007; LeRouge, Ma, De Leo, & Flaherty, 2008; Berry et al., 2010; Valls, Gibert, Sánchez, & Batet, 2010; LeRouge, Ma, Sneha, & Tolle, 2011).

In the subsequent chapters of this report, the design and utilization of a generic user model in SMSS will be further explored to contribute to a better understanding of the role of socio-cognitive factors in tailoring and successful self-management. We will further specify requirements for the components through (a) cooperation with prospective users in focus group meetings (Chapter 3), and (b) specifying socio-cognitive factors that should be included in the user model (Chapter 4).

3 User Perspectives on Behavioural Change Support[4]

Summary

In the previous chapter, we have specified Operational Demands for self-management support systems (SMSS) in a functional model from a medical and scientific point of view. The development of SMSS has indeed been mainly initiated and driven by health-care professionals and researchers, resulting in a primarily medical view on the role of these systems in health care for chronically ill patients. However, patients have to change their life style themselves. Second, lay people consider their health in terms of ‘participation’ and ‘feeling healthy’, rather than medical terminology. Therefore, different views regarding the role of self-management systems in health care for chronically ill patients are to be expected. To refine the Operational Demands using prospective users’ point of view, a focus group interview was conducted with eight patients with a chronic kidney disease. The role of self-management systems in their daily care was discussed, guided by a scenario that was based on the functional model from Chapter 2 (see Appendix A). The results show that opinions and expectancies about the role of SMSS can vary greatly between patients. Furthermore, patients’ expectancies do not necessarily correspond with the role of SMSS from a medical perspective. Expectations about the role of SMSS in supporting behavioural change should therefore be addressed during all design stages. These insights have been used to further specify the contents of components of the functional model in Chapter 2. An important issue that arose in the discussion, was that all patients differ in the way they use an SMSS and the information they want to find in such systems. It is therefore important to tailor SMSS to suit the different types of users. In Chapter 4 we will therefore further investigate which socio-cognitive factors play a role in tailoring, and propose requirements for tailored functionality for SMSS.

[4] This chapter has been published and presented as:

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3.1 Differences in perspectives on behavioural change support

Both patients and healthcare professionals can benefit from a greater adoption of self-management as an approach to face the growing disparity between the demand and the delivery of care. For healthcare professionals, self-management can be beneficial in terms of workload, cost-effectiveness and efficiency in monitoring patients. For patients, a larger degree of self-management enables more reliable monitoring of their condition, empowerment through education and decision-making, and consequently more responsibility regarding their daily health care and lifestyle (e.g. Bodenheimer et al., 2002b). For effective self-management, it is therefore necessary that patients increase their knowledge about their condition, acquire competencies and have the appropriate tools to cope with their condition, and receive sufficient support from professional and lay caregivers.

To support chronically ill patients engaging in these activities, self-management systems are increasingly being applied in interventions (e.g. Lustria et al., 2009). These systems can range in functionalities from registering and sharing self-measurements with physicians to more complex systems that educate patients, enable online communication with professional caregivers and fellow patients, support goal-setting, monitoring and evaluating patients’ health status (Laverman, Alpay, Neerincx, & Schonk, 2011). The research on self-management systems has been largely initiated and driven by health care professionals and the functionalities and roles for these systems are consequently described from a medical perspective.

However, most lay people do not consider their condition from a medical point of view, but rather in terms of ‘participation’ (e.g. being able to do what one wants to do) and ‘feeling healthy’ (e.g. having enough energy and feeling in tune with oneself). This has been reported in a large Dutch study conducted by the Dutch National Institute for Public Health and the Environment regarding the opinions of lay people about health and healthy living (Dutch National Institute for Public Health and the Environment, 2011). Therefore, it is likely that expectancies of patients regarding self-management systems also can be different from the medical perspective on the utilization of these systems in life style based interventions. To get a better insight in such expectations, we conducted a focus group interview with patients with a life style related chronic illness.

3.2 Method: Focus group interview

The main components of the functional model from Chapter 2 (defining problem, setting goal, monitoring health status, evaluating progress, providing health information, and communicating with professionals and peers; see Figure 2.1) were incorporated in a scenario (Appendix A) and use cases (Appendix B) which illustrate the steps a patient with a chronic kidney disease takes to change his dietary behaviours and the support an SMSS can provide. The scenario and use cases were based on the functional model from Chapter 2, and interviews with a nephrologist, a dietician and two patients from the nephrology department of the Leiden University Medical Center, The Netherlands. The model and scenario thus served as an educated framing of the context of SMSS to be discussed with patients, albeit from a medical point of view. To refine the Operational Demands we have subsequently discussed experiences regarding self-management and SMSS in a focus group interview consisting of patients with a reduced renal function (less than 60%), which included a discussion of the scenario[5]. We opted for conducting one focus group interview, as this would give enough input for investigating the different ways that patients manage their condition and discussing the model and scenario. Furthermore, we wanted to involve prospective users again in studying more concrete prototypes of tailored BCS (reported in Chapters 6 and 7).

Participants were recruited through a physician from the Bronovo Hospital, The Hague. Inclusion criteria were: a chronic kidney disease (CKD) (stage 1-3), diagnosed less than two years ago, experience with self-management and internet, and an ability to express themselves well in Dutch. We included patients with CKD, as they have an urgent need to change their life style: they need to change their diet to stabilize their kidney function as much as possible (National Kidney Foundation, 2002). Eight patients with an average age of 52 (range 31-67) participated in the focus group interview. The interview was led by two of the authors of the conference paper that this chapter is based upon (ML and YJ). First, experiences with and opinions about self-management and support through eHealth were discussed. After a short break, the scenario was presented to and discussed with the participants. The focus group lasted two hours.

The focus group interview was taped and transcribed by author ML, after which authors ML and YJ coded the transcription independently, using MaxQDA analysis software (version 10, Verbi Software, Berlin). One of the coders (ML) based the code system on the initial expected outcomes, while the second coder (YJ) used a grounded theory approach (Strauss & Corbin, 1997) to identify themes that were overlooked by the initial expected outcomes. Issues between the two coders were resolved through discussion.

Possible limitations or biases in the group of participants are above average internet use, experience with self-management and above average education level (not measured). Although this is not representative for all renal patients, the group was homogenous and characterises patients that are interested in and should be able to adopt self-management.

3.3 User perspectives on behavioural change support

The identified themes show an overlap between the functional model and the opinions of the participants. The participants especially stressed the importance of self-measurements and feedback from professionals. As one participant stated:

> *(P4) "I feel that taking my own measurements a few times a week is more reliable than just once every few months during the outpatient's visit. This is what my doctor says, and I think so too."*

[5] An earlier focus group interview was conducted, but not reported here. This earlier focus group was small (N = 4) and our experience with this focus group shaped the objectives of the reported focus group.

Participants also emphasized that feedback can be very motivating for them and that self-measuring in itself can provide feedback:

(P5) "If I have exercised and measure my blood pressure, and I see that it has lowered… That is so great, I am even motivated to exercise again!"

(P5) "When you keep a diary of your diet, you immediately have some feedback. This way you can already do something about it after a few days."

This shows that the participants acknowledge the need and benefit of self-measuring and keeping an eye on their health status, and that this can motivate them to change their life style. An important issue changing life style, is that self-measuring and evaluating health status need to be incorporated in their daily life as new routines. From a medical perspective too, it would be ideal that patients keep a daily diary of their diet and take regular physiological measures. However, our participants emphasized that it is not always easy to keep up with this, and patients need to be motivated and often work around barriers to do so:

(P5) "I have to keep a diary of everything I eat – and I mean everything! It is very difficult to keep track of every little ingredient and I find it not possible to do this every day. There are periods I fill in my diary every day, but in other periods I don't."

(P4, regarding adjusting diet) "You have to be very motivated to stick precisely to what you doctor tells you to do. I can imagine that people think 'Why should I do this?' and 'What is in it for me?'"

(P6) "It can be difficult, when I have a busy time at work, have people coming over, yes, I have trouble sticking to my diet. Sometimes days go by, and I suddenly realize I haven't kept to my diet. These periods come and go."

This shows that it is not always practical for patients to use these systems on a daily basis. In fact, most participants do not see the need for daily use either, as opposed to the medical point of view. Generally, SMSS are developed to be used on a daily basis for a long period of time. However, the participants pointed out they are especially relevant and beneficial when one starts to learn a new routine to manage their condition in their daily life:

(P6) "Specifically for patients that are new to changing their diet, I can imagine that such systems are very informative."

(P3) "When I started to change my diet, I found it very appealing to keep a diary and share this with my dietician and get immediate feedback and tangible tips."

Not only are there differences between how health-care professionals see self-management and SMSS, but there are differences between patients too. This became evident when discussing the reasons for taking self-measurements or adhering to their diet with the participants; some participants have a strong intrinsic motivation, while others need external motives to follow their diet:

(P7) "I do it because of the lab results, I think. If I have to hand in blood or urine samples at the hospital, then I keep to the rules very strictly, and then, at the outpatient visit we see, ah, the values are alright."

(P5 replies) "I really do measurements for myself, and not because my doctor wants me to do. Those measurements should give a realistic picture, if three days after a doctor's visit everything is not that good anymore, then it just doesn't work. The doctor maybe even makes a wrong decision based on those measurements."

(P8) "Meals like breakfast and lunch contain almost every day the same items for me and I think for most people. When I know what I can and cannot eat, in my opinion, I wouldn't have to keep a diary for this."

The need for taking into account differences between patients also arose when discussing searching for information and interacting with fellow patients. Participants noted that they found difficulties in deciding which information is relevant and reliable. They also noted that interaction with fellow patients is not always beneficial, and differences in coping style and (co-)morbidities can pose barriers for useful interaction:

(P8) "For a lot of people it is very difficult, you get overwhelmed by information, what information is in fact useful for me?"

(P1) "I would like to get information, but I want to know if and how much it helps, that could make it tangible and motivating. And it should be reliable, information on the internet can be very unreliable."

(P6) "I look up all the guidelines and compare these to what my doctor says. I did extensive searches on the internet, but at one point I stopped. Searching for health information on the internet is very demotivating. Very negative, only misery, you don't read about people that are doing alright."

(P8) "When I look around the table, I see that everyone is very different. It may be difficult to provide the right information for everyone. I therefore wouldn't want to give another patient advice on his condition. (…) There is a danger in that people can be subjective and give advice from personal beliefs."

(P6) "Other patients have experience with their condition and their own body." (Authors' emphasis)

Three participants (P5, P6 and P8) had experience with a currently available Dutch self-management support system aimed at renal patients that want to monitor their diet. This website was developed by health-care professionals with an expertise on CKD, but the participants experienced trouble using it and have a different view on how they want to use it:

(P5) "It takes a lot of time every day, there are so many products to choose from, but none of them are exactly the product I use."

(P8) "I don't want to know exactly how much of each nutrient I eat, but rather in general which kinds of food contain which kinds of nutrients."

As we can see, there is agreement between patients and professionals on the functionalities that these systems should contain. However, there are some differences regarding daily use and roles of self-management systems. In addition, we have seen the differences there are between patients. For instance, some patients want to have extensive and detailed information about their diet:

(P8) "Personally, I would like to see all the specific details about my measurements."

While others settle for more general information and the main essentials regarding their salt intake:

(P6) "My doctor says 'less is better', but for me, I want to know how much is sufficient and what is really important?"

3.4 Implications of user perspectives for functional model

The results from the focus group interview are primarily used to further specify the components of the model. The prospective users stress that SMSS can especially be of importance to learn new routines: measuring and registering self-measurements not only has a medical value (i.e. keeping track of health status), but for patients it also has an important educational and motivational value. This has for instance implications for problems or goals that users select when using SMSS; more personal or practical problems or goals instead of purely medical problems and goals could be more useful for patients. Hence, SMSS should suggest goals tailored to users' situation and preferences. Moreover, SMSS need to take into account that some users have a desire for extensive details concerning their goals and measurements (and consequently feedback on those measurements), while others settle for a more general approach focusing on key guidelines. When designing functionality for SMSS, this should be given appropriate consideration. For instance, patients who appreciate a more general approach can be supported by smartphone apps that provide information on nutritional values of products by scanning product barcodes, instead of learning by heart or through self-measurements.

Second, the participants noted that it is essential for information and interaction with fellow patients to be relevant and reliable. For communication with peers, this means that the system should enable recognizing reliable and knowledgeable users who provide useful information for others. Tailoring based on a user model can provide means to offer relevant information for individual users and signify its reliability (this is further elaborated upon in Chapter 5). Also important in this regard is communicating information in a positive manner to motivate patients.

3.5 Conclusion & Discussion

In this chapter we have presented the different perspectives on the use of SMSS to support patients with a chronic condition. We argue that it is necessary to utilize a co-creation approach when designing these systems. Furthermore, by using the different roles and cognitive characteristics of users, these systems should be tailored. Determinants and characteristics that underlie tailoring remain important challenges in further research. In Chapter 4 we will therefore investigate the role that socio-cognitive factors play regarding tailoring information in SMSS. Insights from psychology, cognitive science and communication are explored to develop a requirements baseline for tailored functionality in SMSS.

The results show that health care professionals' expectations of the use of self-management support systems in self-management interventions are not always congruent with the views and expectations of patients. As these systems are still largely developed based on medical requirements this means that there is a discrepancy between what SMSS offer and what patients require to manage their chronic condition. This shows the importance of involving the anticipated users during the design of self-management systems.

Although strategies of participatory- and user-centred design are increasingly utilized in the development of medical ICT applications, usability studies for these applications have suffered from a lack of quality and structured reporting. This results in increased development costs for adjusting or redesigning these application and concerns about (use) errors and safety risks associated with these applications (see e.g. Horsky, Kuperman, & Patel, 2005; Peute et al., 2013). It is therefore imperative to adapt a co-production approach with patients, care providers and designers in the development of these applications (see e.g. Boyle & Harris, 2009). Challenges in the design process must be addressed by carefully managing ownership and responsibilities between the stakeholders (Prahalad & Ramaswamy, 2004).

Next to a discrepancy between health care professionals and patients, the results show a difference between patients regarding the role of SMSS: ranging from a general guidelines approach to an extensive tool to manage day to day care in depth. Chronically ill patients have the freedom – and responsibility! – to organise the daily care of their condition. Accordingly, this has consequences for the use of SMSS. It is therefore necessary to tailor SMSS to different approaches that patients prefer (e.g. gain insight in and share dietary measurements with professionals or peers, learn new routines, or gain more knowledge about one's condition). This is also highlighted by current work on patient profiles and tailored care plans, which focuses on 'what works for who' – what type of patient needs what kind of intervention (Jedeloo, Van Staa, Latour, & Van Exel, 2010).

4 Socio-cognitive factors in Personalized Behavioural Change Support[6]

Summary

In the previous chapters we have described the Operational Demands for self-management support systems (SMSS). In this chapter we will address the socio-cognitive theories that play a role in tailoring SMSS to different users, and propose Core Functions and Claims to justify personalized functionality.

Using differences between users to match information to (cognitive) characteristics of individual users can aid understanding and persuasion of information in BCS. A widely used and investigated form of tailoring is to match the content of information to what is relevant for an individual user. Interventions based on this form of tailoring have been able to positively influence health outcomes compared to generic interventions. However, this research has focused on testing whether tailoring is effective or not, but has not addressed the factors underlying personalisation of information. In this chapter, we will address this issue by using insights on how people process and are persuaded by information, and the implication for the design of personalized information. This chapter will provide socio-cognitive factors that can be used to personalize information, and we will propose Core Functions and Claims for personalized functionality based on the Elaboration Likelihood Model of Persuasion. In Chapter 5 we will further specify these Claims and develop Design Patterns for personalized information in SMSS. In the subsequent chapters we will report on the validation and further refinement of these requirements.

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[6] A preliminary version of this chapter has been presented as:

Laverman, M., Alpay, L.L., & Schonk, Bertie J.H.M. (2011, November). *Gebruikerskarakteristieken voor zelf-management systemen op maat.* Presented at Medisch Informatica Congres, Veldhoven, The Netherlands.

4.1 Tailored information for behavioural change support

An important prerequisite for the success and effectiveness of SMSS is that patients understand information that is communicated to them through SMSS, learn from this information and are able to apply the acquired knowledge to novel situations. Furthermore, messages in SMSS need to persuade and encourage patients to act upon these messages. To successfully achieve this, information in SMSS needs to be tailored to the individual users of such systems. This means that information in SMSS should be relevant to the user's situation and match the user's preferences and abilities to understand and be persuaded by information. Building on the notion that different people need different information mentioned by patients in our focus group (see also Chapter 3), tailoring utilizes differences between people's situation, behaviours and cognitions to shape the content and design of messages to match individual users.

The most trivial form of tailoring is matching the content of the message to which information is relevant to a user (Hawkins et al., 2008). This form of tailoring has been widely utilized and evaluated to date. Meta-analyses have shown that such tailored interventions are more effective in changing health behaviours and health outcomes for participants that received tailored information, as opposed to participants that received no or generic information (Noar et al., 2007; Lustria et al., 2009; Krebs, Prochaska, & Rossi, 2010; Radhakrishnan, 2012; Lustria et al., 2013). The possibilities for matching the content of information to users are myriad, and the specific context or disease in which an SMSS is applied determines for a great part which variables can be used for tailoring information. Examples of variables that are used to successfully tailor information are for instance, using personal data like the receiver's name, age or gender to point out a message is intended for the recipient (Dijkstra, 2005; Dijkstra & Ballast, 2012; Mathew, Gucciardi, De Melo, & Barata, 2012), giving feedback on self-reported measurements, stage of change or health-related behaviours to compare with norms or comparable social groups to enhance persuasiveness (see e.g. Kroeze et al., 2006; Lustria et al., 2009; Neville, O'Hara, & Milat, 2009), and using culturally relevant examples or advice to relate to receivers' daily life to increase understanding and persuasiveness (e.g. Migneault et al., 2012; Sun, Tsoh, Saw, Chan, & Cheng, 2012).

A much less implemented and researched form of tailoring information in SMSS however, concerns utilizing how people process and are persuaded by information. This form of tailoring shapes the design of the message (how to convey the message), rather than the content of the message (what to convey). By focusing on this form of tailoring, tailoring research and implementation in SMSS can be taken a step further from merely testing whether tailoring is effective or not, to a better understanding of the attributes that underlie personalizing information (Hawkins et al., 2008; Lehto & Oinas-Kukkonen, 2011; LeRouge et al., 2011). This chapter will therefore focus on this latter form of tailoring and how to systematically implement personalization of information in SMSS.

We will inventorize the socio-cognitive factors which play an essential role in personalizing communication in SMSS. To be able to personalize information, we are looking for socio-cognitive factors that address individual differences between people in changing their behaviour, and comprehending and acting upon information. Furthermore, these socio-cognitive factors should be reliably assessed and parameterized, to be able to build a user model that characterizes the user and can be used to determine how to tailor the message (Fischer, 2001). The user model is not a static set of values, but should be dynamic and reflect users' current state, as the assessment of socio-cognitive factors can change over time, for example, chronically ill patients' knowledge of their disease can increase over time (Kennedy et al., 2012).

First, we will discuss key theoretical models in behavioural change and personalizing communication, and derive socio-cognitive factors that are important in and suitable for determining how and when to personalize information. Second, we will select the model that is best suited to be used in subsequent chapters to design and validate personalized information for SMSS, i.e. clearly addresses the individual differences between people and the consequences for communication, and provides reliably measureable socio-cognitive factors to be used in the user model.

4.2 Method: Literature research

We have selected key theoretical models on (1) behavioural change in the health care domain and (2) tailoring of information and communication, based on the authors experience from health care, psychology and information and communication technology and have searched Pubmed (http://www.ncbi.nlm.nih.gov/pubmed/) and Google Scholar (http://scholar.google.com), not limited by time period. The keywords 'behavioural change' combined with 'health care', 'life style', 'chronic disease', 'model' and 'theory' (1), and 'tailoring' combined with 'information', 'communication', 'model' and 'theory' (2) were used. Based on title and abstract we selected publications (N = 45) that present relevant models and/or elaborate on the socio-cognitive factors that play a role in these models. Further relevant literature was selected by reviewing the reference lists of the selected publications. We did not aim to select all available theoretical models, but rather those that are suitable for use in supporting behavioural change with SMSS.

From the selected models, we have derived socio-cognitive factors that can be used to determine which communication strategy to use. Furthermore, reliable assessment methods of these socio-cognitive factors should be available. Subsequently, we have derived claims concerning the effects of these socio-cognitive factors on communication strategy.

4.3 Socio-cognitive factors for personalized behavioural change support

Below we will elaborate on the results. First, we will describe theories regarding and related to behavioural change. Before starting to change behaviour, individuals need to go through a process of motivation to change to increase their *intention* to change their behaviour. In BCS it is important that feedback for users keeps them motivated. Paragraph 4.3.1 will therefore discuss the theories and constructs that play a role in intention, before we describe the theories and constructs that are important in the actual *behavioural change* process in 4.3.2. Regarding intention we will elaborate on the Theory of Planned Behaviour (TPB; Fishbein & Ajzen, 1975; Ajzen, 1991, 2011). We will continue with describing the transition from intention to behaviour in the behavioural change process based on the Trans Theoretical Model

(TTM; Prochaska & DiClemente, 1982; Prochaska & DiClemente, 1983), Self-Regulation Theory (SRT; Maes & Karoly, 2005; Leventhal, Weinman, Leventhal, & Phillips, 2008) and the Health Action Process Approach (HAPA; Schwarzer, 2008). Other theories that play a role during behavioural change will be related to the stages of the process.

Second, we will describe theories and constructs that play a role in *communication* in paragraph 4.3.3. The most important objectives for communicating in SMSS are sharing knowledge, giving and receiving feedback, and persuasion. We will elaborate on the socio-cognitive factors that play a role in these and related objectives based on Te'eni's Cognitive Affective Model (CAM; 2001), Feedback Orientation (Ashford & Cummings, 1983), Fogg's work on Persuasive Technology (PT; e.g. Fogg, 2003) and the Elaboration Likelihood Model (Petty & Cacioppo, 1986). A summary of the socio-cognitive factors that are important for personalizing SMSS can be found in Table 4.1 and Figure 4.1.

4.3.1 Intention to change behaviour

Early work on behavioural change, most notably the Theory of Reasoned Action (TRA; Fishbein & Ajzen, 1975) and its extension the Theory of Planned Behaviour (Ajzen, 1991) has primarily identified the determinants of intention to perform a desired behaviour (Ajzen, 2011), namely attitude towards, perceived social norms and self-efficacy regarding the behaviour. TRA and TPB show the importance of motivating patients and keeping them motivated when performing self-management, which has also been stressed by patients that have experience with self-management (Laverman et al., 2012). The determinants identified by TRA and TPB are as such important to consider when tailoring information. Comparison with positive social norms can be used for personalising information or feedback, or help identify problems and set goals. Information and feedback should aim at positively influencing attitude and strengthen patients' self-efficacy. These latter two will be elaborated in more detail below. An important limitation of TRA and TPB is, however, the 'intention-behaviour gap': a high intention to perform a desired behaviour does not necessarily lead to the actual behaviour (see Sheeran, 2002; Fishbein, Hennesy, Yzer, & Douglas, 2003; Ajzen, 2011).

4.3.2 Behavioural change process

The principal contemporary behaviour change theories that try to explain the intention-behaviour gap are Self-Regulation Theory (for a review see Maes & Karoly, 2005; Leventhal et al., 2008) and the Health-Action Process Approach (Schwarzer, 2008). Both are influenced by the Trans Theoretical Model (Prochaska & DiClemente, 1982, 1983), which recognizes, as opposed to TRA and TPB, that people progress through a number of stages when attempting to change their behaviour and can relapse when they encounter difficulties or problems, as we have also argued in Chapter 2. The stages and processes described by the TTM can and have been effectively used to personalize messages. However, it does not differentiates different communicative strategies that determine the form of messages.

Building on the TTM, SRT and the HAPA describe the underlying mechanisms that determine the transition from intention to behaviour. Self-regulation explains how a goal-directed approach can improve the attainment of a desired behaviour. Comparable to the framework presented in Chapter 2, SRT advocates (1) selecting appropriate goals to express a specific desired behaviour, in accordance with one's larger personal goal structure, (2) set a goal that one believes one can achieve (i.e. feel self-efficacious to reach the goal) and think about how to cope with setbacks (Gollwitzer, 1999; Gollwitzer & Sheeran, 2006), (3) actively pursuit their goal (e.g. change their dietary habits and keep a diary to register their diet), and (4) maintain their behaviour when they have achieved their goal. HAPA further specifies the process of behavioural change by integrating both the mechanisms that explain intention (i.e. motivational processes) and the self-regulatory processes that guide behaviour realisation (i.e. volitional processes). HAPA importantly recognizes the possibility of setbacks after a desired behaviour has been mastered ('recovery').

An important human factor in all stages of behavioural change is self-efficacy, the belief that one can achieve a certain goal (Bandura, 1997; Maes & Karoly, 2005; Schwarzer, 2008). Self-efficacy can be different for different goals, situations and stages of behavioural change. Accordingly, when developing tailored SMSS this should be taken into account. Personality traits that are closely related to self-efficacy can have implications for contextualizing communication in SMSS (Judge, Erez, Bono, & Thoresen, 2002; Lightsey, Burke, Ervin, Henderson, & Yee, 2006). Two traits are most apparent in this regard: locus of control and neuroticism (see e.g. Disler, Gallagher, & Davidson, 2012; Ahola & Groop, 2013).

Locus of control describes whether people attribute their success to their own personal success (internal locus of control) or to luck, chance or powerful others (external locus of control; Wallston & Wallston, 1978; Rothbaum, Weisz, & Snyder, 1982). Research with both patients and non-patients has shown that people with a higher internal locus of control have a greater preference for shared decision making and receiving more comprehensive information, in contrast to people with a more external locus of control (Hashimoto & Fukuhara, 2004; Schneider et al., 2006). Hence, a personalized SMSS can provide more comprehensive information and a wider range of treatment options (i.e. behavioural problems to work on, goals to achieve, self-measurements to take) to users with an internal locus of control, while users with an external locus of control might be better supported by giving concise, to the point information and advice on how to change behaviour.

Neuroticism is a personality trait which is characterized by a negative mood, worry and anxiety (Thompson, 2008). There is evidence that this trait has a negative effect on self-management behaviour (Disler et al., 2012; Oosterom-Calo et al., 2012; Zulman, Rosland, Choi, & Langa, 2012). People with a neurotic personality trait can have difficulties in setting realistic goals, as they are inclined to think they will fail at reaching their goal. SMSS communication during goal setting can therefore be aimed at setting a goal that the user imagines he can successfully achieve (Bandura, 1986). Furthermore, in the face of difficulties to attain their goal, people with a neurotic personality have a greater chance to abort their attempts or slacken their efforts. Personalized feedback in SMSS should be aimed at recovering their self-efficacy after setbacks (Bandura & Cervone, 1983).

Last, when people are actively pursuing their goal, feedback on their progress is important to stay motivated (e.g. Laverman et al., 2012). When people face difficulties in attaining a goal, motivation can diminish and self-doubt can set in. Motivational interviewing strategies can be utilized to support people in dealing with difficulties (Miller & Rollnick, 2002), and can be utilized to give automatic feedback (for an example, see Schulman, Bickmore, & Sidner, 2011), using understandable language personalized to the user (this will be elaborated below). Also, enhancing affectivity by including positive messages to the user can support when motivation is low and mood is negative (Te'eni, 2001).

4.3.3 Communication strategies

One of the most important aspects of communicating (health) information in SMSS is that the receiver of the information understands the information. It is therefore vital that information in SMSS is tailored to the socio-cognitive factors that determine the successful understanding of the information.

Knowledge about one's disease, treatment options and healthy behaviour has been recognized as one of the key enablers for successful self-management (Barlow et al., 2002; Lorig & Holman, 2003) and can be used as a determinant for tailoring information. An example of this has been published by Alpay et al. (2008), who have shown that providing more contextual information to a message supports understanding of the message by people that have a lower knowledge. This way, users of SMSS can be supported in choosing the right problems and goals for their situation. Alpay and colleagues' work was inspired by the CAM (Te'eni, 2001), which explains the factors that play a role in mutually understanding communicative messages between sender and receiver, and shows which communication strategies can be used to lower the complexity of messages. The goal of communication in SMSS is twofold, information in SMSS is used to share knowledge and build trust between the SMSS and the user. Cognitive and affective complexity respectively impact these two goals. The work of Alpay and colleagues is an example of tailoring the cognitive complexity of a message to the receiver and thus support users to understand information. To tailor affective complexity, SMSS should address user's mood or emotions and support them to develop positive emotions towards managing their condition.

As argued before, feedback on patients' progress towards goals and self-measurements is an important mechanism for SMSS to support patients to stay motivated and enhance their self-management abilities. Data from registering self-measurements can be used to personalize feedback (e.g. Colkesen et al., 2011). However, there are also individual differences in how people seek and process feedback. Ashford and Cummings (1983) have suggested two strategies that people use to seek feedback, monitoring and inquiry. They have proposed a number of determinants for feedback seeking strategy. The most apparent determinant for SMSS is individuals' desire to receive accurate feedback. Ashford and Cummings propose that individuals that have a high desire to receive accurate feedback will actively seek feedback (inquire). For SMSS this means that users with a lower desire should receive more feedback cues from the system, while users with a higher desire will inquire for feedback more automatically. More recent research has developed the Feedback Orientation Scale which includes measurable dimensions of feedback orientation which can be used to tailor information: feedback utility, feedback accountability, social awareness and feedback self-efficacy (London & Smither, 2002; Linderbaum & Levy, 2010). For instance, the accountability dimension measures whether individuals feel obligated to react and use feedback. For users who score low on this dimension, SMSS should incorporate more messages that appeal to users' sense of personal accountability for their health.

Table 4.1 Socio-cognitive factors for tailoring. TPB: Theory of Planned Behaviour; ELM: Elaboration Likelihood Model; PT: Persuasive Technology; SRT: Self-Regulation Theory; HAPA: Health Action Process Approach; CAM: Cognitive-Affective Model.

Factors for tailoring	*Theory*	*Functionality in SMSS*	*Content of information in SMSS*
Attitude	TPB ELM	Identify problems Set goals	Contents should be aimed at enhancing positive attitudes Strong arguments or affective cues as tailoring strategy
Social norms Culture Generation	TPB PT	Identify problems Set goals Feedback Information	Compare with social norms to help select problems and goals Compare with social norms to enhance motivation and self-efficacy Persuade and motivate by using attractive source according to culture or generation
Self-efficacy	TPB SRT HAPA	Identify problems Set goals Feedback Information	Select problems where self-efficacy is high first Set attainable goals for which self-efficacy is high Motivate when difficulties to attain goal
Locus of control		Identify problems Set goals Feedback Information	Higher internal locus of control, more comprehensive information and treatment options
Neuroticism		Identify problems Set goals Feedback	Encourage user to visualize success in attaining goals Personalized feedback to enhance self-efficacy recovery
Motivation	CAM	Registering measurements Feedback	(Automatic) Motivational interviewing strategies Include positive messages to show affectivity (e.g. address user's mood or emotions) Personalized feedback to enhance self-efficacy recovery
Domain knowledge	ELM CAM	Identify problems Set goals Feedback Information	Provide more contextual information when domain knowledge is low
Feedback orientation		Registering measurements Feedback	Include more feedback cues when desire to receive feedback is low
Communicative style	PT	Feedback Information	Use communicative style (e.g. dominant or submissive) that matches user

An important aspect of inducing behavioural change through self-management systems is persuading patients to act upon the messages they receive from SMSS. A comprehensive body of work concerning how technology can be utilized in persuading its users, is published by Fogg in his book Persuasive Technology (2003). Although Fogg’s work offers insight in the general strategies that make technology persuasive, there is only modest acknowledgement for the differences between people in the way they are persuaded. Opportunities for tailoring persuasive information to characteristics of patients lie particularly in the use of technology as social actor. Fogg shows that physical, psychological and language cues can be utilized as persuasive strategies. To be effective, these cues should match the characteristics of patients using SMSS. A physical cue like an attractive appearance can enhance persuasion and motivation (Fogg, 2003), but what is seen as attractive can vary between cultures and generations. Therefore, SMSS should take into account age and cultural group to match the overall design and appearance of coaches (e.g. avatars) to individual patients, much alike the social norms that TPB specifies. Psychological cues can guide how users perceive the ‘personality’ of a system. This can also be utilized in SMSS to tailor the personality of a coach to match the characteristics of patients. For instance, when communicating in a more dominant or submissive manner, people are more persuaded by using a communicative style that matches their personality (Nass, Moon, Fogg, Reeves, & Dryer, 1995). Language cues entail the way something is communicated, for instance in a positive (e.g. ‘You have almost reached your goal, keep it up!’) or negative manner (e.g. ‘You did not reach your goal, you have to do better’).

Persuasive information in SMSS should also be aimed at positively influencing patients’ attitude towards healthy behaviour in accordance with their disease. Attitude is one of the factors that plays an important role in intention to change behaviour. Attitudes are formed by evaluating information about and experiences with a desired behaviour (Eagly & Chaiken, 2007) and is therefore especially suited to be influenced by information in SMSS. The Elaboration Likelihood Model (ELM; Petty & Cacioppo, 1986) is a comprehensive model describing a dual process of attitude formation via a *central* and a *peripheral* route. The central route entails highly elaborating on information, e.g. carefully scrutinizing information, weighing options and imagining what it means for your personal situation. Processing information via the peripheral route, is a more superficial and low elaboration of information. Central processing occurs when people have both the motivation and the ability to highly elaborate on information. If information is centrally processed, the message should contain strong arguments to persuade the receiver of the argument and positively influence his attitude. When motivation or ability to elaborate on information are low, information is processed more peripheral. During peripheral processing qualitative aspects of the information, or affective cues – e.g. if it looks good, or is communicated by a credible or attractive source – can positively influence attitude. Important to note, however, is that the quality of attitude is determined by the route of processing. During central processing, strong and stable attitudes are formed, but attitudes that are formed during peripheral processing are weak and easily dismissed over time or when setbacks occur. It is therefore important to match the way information is presented in SMSS to the route of processing by determining patients ability and motivation to elaborate on information. The ability to elaborate is determined by level of education or level of knowledge someone has about a subject, and can be enhanced by repeating complex information. People with a higher education or a higher knowledge of a subject are more capable of critically evaluating information, and by repeating complex information SMSS can offer greater cognitive resources for elaboration. Motivation to elaborate is enhanced by offering personally relevant information, and determined by the Need for Cognition (Petty & Cacioppo, 1986) of the receiver. Level of education and knowledge, and Need for Cognition can as such be used to determine whether strong arguments or affective cues are needed to convey the information.

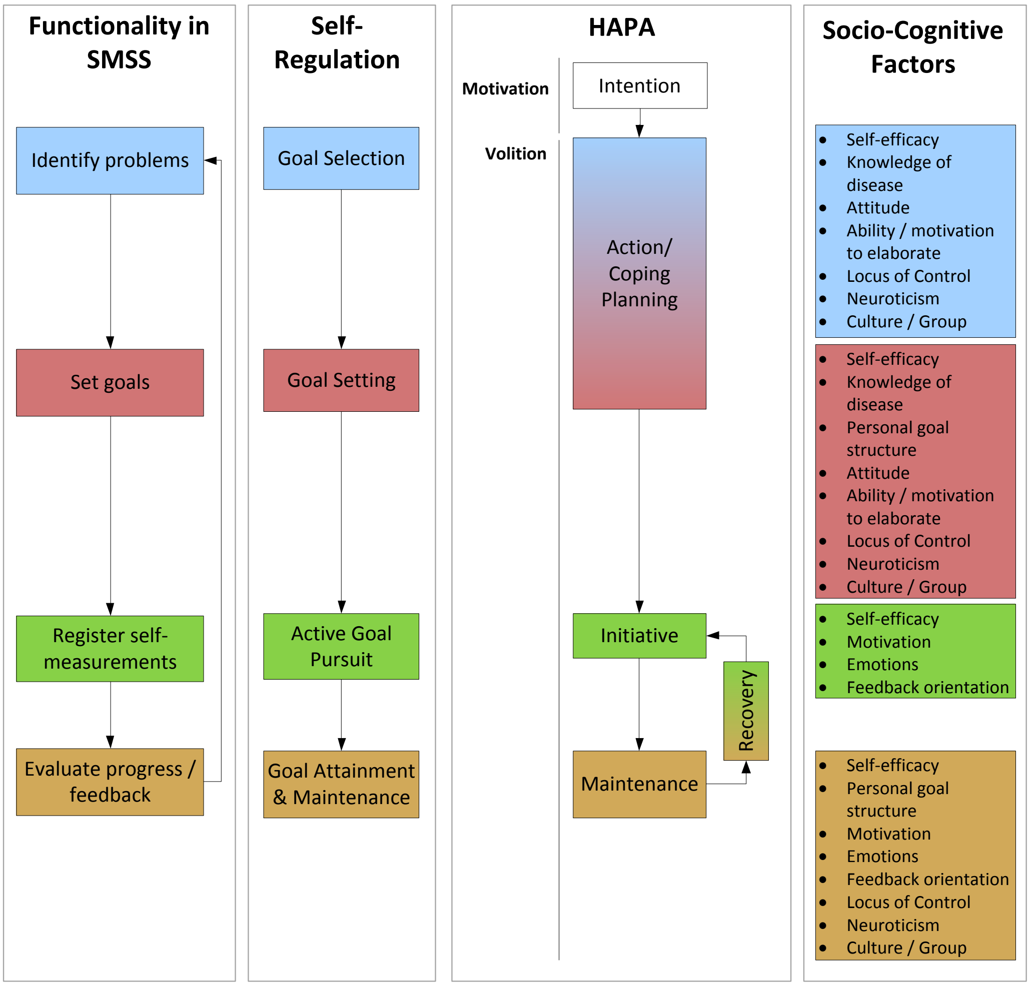

Figure 4.1 Processes of behavioural change, support functionality in SMSS and socio-cognitive factors that play a role in supporting these processes. Use of colours is similar to the functional model in Figure 2.1. HAPA: Health Action Process Approach.

4.4 Conclusion & Discussion

In this chapter we have presented socio-cognitive factors that play a role in behavioural change and communicating information and can be used to personalize information in BCS. We have argued that the ELM is a valuable model to base personalization of information on. First, attitude plays an important role in persuading people to change their behaviour, and ELM offers an evidence based model of how attitudes are formed. ELM shows that there are differences between people that have an impact on the way information is communicated, and can thus serve as a basis for personalization. Furthermore, it provides reliably measurable socio-cognitive factors that can be used to decide how to present information to individual users. We will therefore use the ELM to develop requirements for personalized functionality in SMSS in the subsequent chapters. In Chapter 5 we will further elaborate on the rationale for ELM as a basis for personalization and provide Claims and Design Patterns for personalized information based on ELM. In Chapters 6 and 7 we will describe a study into the feasibility of these requirements.

The ELM has been widely applied and tested in studies concerning attitudes of students towards topics ranging from exercise intention (Rosen, 2000), environmental preservation (Wood, Kallgren, & Preisler, 1985), politics (e.g. voting (Lavine & Snyder, 1996)) to university policies (Petty & Wegener, 1998), and in studies concerning marketing and design of advertisements (Alba & Marmorstein, 1987; MacKenzie & Spreng, 1992; Wilson & Sherrell, 1993; Tripp, Jensen, & Carlson, 1994; Christensen, Ascione, & Bagozzi, 1997; Sengupta, Goodstein, & Boninger, 1997; Priester & Petty, 2003). In healthcare, ELM has been applied in educational information concerning smoking prevention (for review see Flynn, Worden, Bunn, Connolly, & Dorwaldt, 2011), alcohol counter-advertising (for review seeAgostinelli & Grube, 2002), compulsive gambling (Munoz, Chebat, & Suissa, 2010), obesity education (Hague & White, 2005), AIDS prevention (Igartua, Cheng, & Lopes, 2003), mammography screening (Kirby, Ureda, Rose, & Hussey, 1998) and food labelling (Walters & Long, 2012).

It is important to note that the majority of these studies have studied attitudes of university students towards the subject, and thus the group of participants varies greatly with respect to the target group of the information. This has implications for the personal relevance of the information. Relevance has been manipulated by instructing participants that their task is important (e.g. an important decision is made based on their opinion) or unimportant (e.g. participants have to check spelling errors, but their results will be checked by an editor). These situations differ greatly from the situation of users of SMSS. Not only is the mode of message delivery different (communication via SMSS), but also information in SMSS is of essential relevance to the users. They are confronted every day with their chronic condition and they have to comply with the information to refrain their health status from deteriorating. Furthermore, previous research was only concerned with whether participants were persuaded by the information or not. Information in SMSS is indeed used to persuade users to change their behaviour, but it is additionally aimed at educating users and users should be able to apply the information in their daily life.

Knowledge of the socio-cognitive factors that play a role in tailoring information, can also be utilized in the research into patient profiles. Patient profiles can be utilized to decide which intervention suits which patient best. By matching intervention characteristics to personal characteristics of patients, the most efficient intervention for individual patients can be selected. For instance, not all patients are able to autonomously carry out self-management activities and therefore would be more suited to a personal approach with regular visits to nurse-practitioners to support them. By characterizing interventions based on – amongst others – their socio-cognitive factors characteristics suitable matches between intervention and patient can be made.

We have described socio-cognitive factors and communication strategies that can be used to personalize information in SMSS to individual characteristics of its users, derived from socio-cognitive theories. In Chapter 2 we have described a functional model of an comprehensive self-management support system (Laverman et al., 2011), based on theoretical insights from the self-management literature. There are considerable parallels between this framework and theories of behavioural change (see Figure 4.1). In Chapter 2, we have argued that learning to cope with a disease is essentially a problem solving cycle consisting of four steps patients have to take to cope with problems they encounter ('Functionality in SMSS'). In behavioural change theories, comparable processes have been advocated (see 'Self-Regulation' and 'HAPA'). Figure 4.1 summarizes the steps in the behavioural change process and the socio-cognitive factors that play a role in this process and are usable for personalizing information in SMSS. The next step is to take these socio-cognitive factors and communication strategies and translate these into formal requirements, claims and design patterns for personalized SMSS. These will provide the basis for deciding on personalization of information and communicative strategies in SMSS, and validating these strategies in a real life setting.

5 Designing Behavioural Change Support based on the Elaboration Likelihood Model

Summary

In the previous chapters we have argued for personalized information as a crucial component for supporting patients to change their behaviour to cope with their condition. In Chapter 4 we have concluded that the Elaboration Likelihood Model (ELM) offers a suitable theoretical basis for personalizing persuasive information. In this chapter we will operationalize the theoretical insights from ELM into claims and design patterns that describe the requirements for personalized BCS.

ELM describes two modes of information processing when forming attitudes. People can explicitly scrutinize and think about information (high elaboration), or more superficially process information and rely more on their intuition (low elaboration). To be able to highly elaborate on information, people need to have the ability and motivation to do so, when they lack the ability or motivation the information will be low elaborated upon. The formation of attitudes during high elaboration is aided by presenting a strong argumentation, while during low elaboration affective cues like the source of the information have a greater impact on attitude. We will present claims about how the factors ability and motivation can be used to determine to present personalized information containing either strong arguments (SA) or affective cues (AC).

Second, this chapter will address how SA and AC are designed. What exactly are strong arguments and affective cues? We will propose design patterns that describe the rationale and design of both SA and AC, and can be (re-)used in the development of personalized information for BCS.

Utilizing a methodological approach in designing functionality is beneficial for both current and future development of personalized BCS. The documentation of validation of Claims and Design Patterns enables an evidence based approach. When comparable Use Cases are encountered in future designs, Requirements, Claims and Design Patterns can be reused.

In the next chapters we will report on a study into the feasibility of using the Design Patterns and Requirements from this chapter.

5.1 The Elaboration Likelihood Model as a basis for personalizing information

In the previous chapters we have argued that it is important to personalize information to match patients specific situation and cognitive abilities. As concluded in chapter 4, the Elaboration Likelihood Model (ELM; Petty & Cacioppo, 1986) offers a well suited theory to personalize persuasive information in BCS. The ELM is a dual-process theory (e.g. Sloman, 1996) that takes into account the differences between people when processing information. It recognizes that information processing ranges from more implicit processing (e.g. unconscious, intuition) to more explicit processing (e.g. conscious, reasoning). The extent to which information is processed in a more implicit or more explicit manner, depends on situational and personal factors (*situated cognition*).

According to ELM, when information is processed to form attitudes, people ‘elaborate’ on the information. Elaboration entails the extent to which someone thinks about an object of thought. When people explicitly scrutinize information, weigh their options and think about what the information means for them, the ELM calls this high elaboration. The more implicit and superficial process in which people more rely on their intuition is called low elaboration.

The extent of elaboration on information has consequences for how the information is presented to users of BCS. When highly elaborating information, people are persuaded by the strength of argumentation in information. BCS thus need to present information based on strong arguments (SA) in favour of healthy behaviour to persuade users to change their behaviour. Attitudes that are formed during high elaboration are strong and stable over time and can withstand setbacks in the behavioural change process. During low elaboration, however, users are more influenced by qualitative aspects of information. In this mode, affective cues (AC) in persuasive information (such as a credible and trustworthy source; see for a review Pornpitakpan, 2004) have a greater impact on attitudes that are formed than strong arguments. Attitudes that are formed during low elaboration are weak and easily abandoned.

In addition to the two modes of information processing and how they influence presenting information to users of BCS, ELM specifies the conditions under which high and low elaboration occurs. Two sets of socio-cognitive factors determine the extent to which people elaborate on information, that is, whether a person has the *ability* and the *motivation*[7] to elaborate on information. Ability entails whether someone is actually capable of critical evaluation of information. A person is highly able to elaborate on information when (1) there are sufficient cognitive resources available (i.e. he is not distracted during elaboration, or complex information is repeated), and (2) when he has a high level of education or relevant knowledge of the domain. Motivation is entails whether a person has a reason to elaborate on information. A person is highly motivated to elaborate on information when (3) the information is personally relevant to him, (4) he is solely responsible for developing the attitude, and (5) he has a high ‘need for cognition’ (i.e. he enjoys thinking about and discussing a subject, and enjoys solving problems).

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[7] We are aware of similar connotations to the concepts of *intention* and *motivation*. We use *intention* to indicate an intention to *perform a desired behaviour*, and *motivation* is used to refer to the motivation to *elaborate on information*.

Of these five factors that entail ability and motivation to elaborate on information, two factors are of interest to determine the personalization strategy for persuasive information in BCS: (2) level of education or relevant knowledge, and (5) need for cognition. These two factors are different for individual users and can be reliably assessed. The other three factors do not have enough discriminative value in the context of BCS. Availability of cognitive resources can be maintained in BCS, by presenting complex information twice and by asking patients to minimize distraction. Information in BCS is at all times relevant and important for users and their health. Although the social environment (family, peers) is an important aspect in self-management (see Chapter 2), the attitude someone has towards a desired behaviour is very personal. Patients have to personally change their behaviour, and therefore the personal responsibility for attitude- and behavioural change in BCS is high.

Figure 5.1 offers a schematic overview of how information in BCS is processed by users. The socio-cognitive factors ‘Ability’ and ‘Motivation’ determine which of the two modes of information processing are utilized, and as such can be used to determine which form of persuasive information should be presented to specific users of BCS.

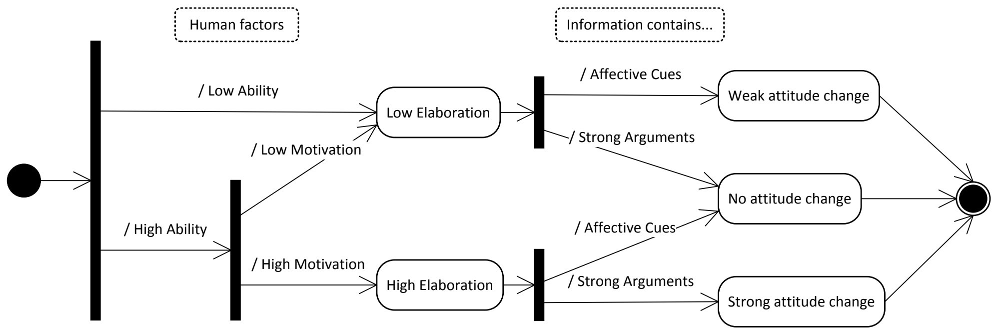

Figure 5.1 Schematic overview of information processing when forming attitudes according to the Elaboration Likelihood Model

5.2 Scenario and Use Cases

We wrote a scenario to illustrate the context in which BCS are used to support patients to change their life style (see Appendix A). From this scenario, use cases were derived that describe activities that can be carried out with BCS in depth (see Appendix B). To demonstrate how the ELM can be used to personalize information, we provide a short scenario below (derived from the scenario in Appendix A).

Bob has read some information about lowering his high blood pressure, but he is interested in the information from the SMSS to check for himself what he can do about it. He decides to open the 'Information' pages, where he can find information and frequently asked questions about high blood pressure. The SMSS asks Bob if he wants to answer some questions about himself, so the information can be tailored especially to his situation. Bob likes this idea: "There is so much information, I'm happy to get the information that is especially relevant for me!". The SMSS shows questions about his medical condition and if he likes to think about and solve problems. When Bob has answered these questions, the information page appears. Bob sees a movie clip in which a doctor explains the factors that play a role in high blood pressure.
Bob understands that a lower blood pressure can be achieved in different ways and that these can differ from person to person. "I didn't know that," Bob realizes, "what would be best for me to begin with?" Bob learns that salt, obesity, low exercise and eating liquorice can be harmful for his blood pressure. Bob does use salt regularly when eating, and he likes to eat fries once in a while. But, if this helps him to lower his blood pressure he is keen to change that. Bob shows his wife: "Look what I can do to change my high blood pressure!" "Maybe we should try to use less salt, I read in the newspaper that Dutch people in general eat too much salt," she replies. Bob thinks this is an excellent idea.

The scenario illustrates that the BCS can show Bob the information using a communication technique that suits him best (i.c. a movie clip in which a doctor explains something), but only after the system has measured certain socio-cognitive factors (i.c. Need for Cognition). In a more formal manner, this scenario can be formulated as a use case describing the user navigating to BCS pages containing personalized information about reducing blood pressure for CKD patients. The use case is presented in Table 5.1.

Table 5.1 Use case 'Search for information about lowering blood pressure', which specifies the goal and actor of the use case, preconditions that need to be met before the use case, postconditions that will be met after the use case, the sequence of procedural steps in the use case (activity), and requirements that are related to this use case.

UC001	Search for information about lowering blood pressure
Goal	User has been diagnosed with a chronic kidney disease (CKD) and been instructed by his physician to lower his blood pressure. User wants to know why he has to do this, and how he can realise this.
Actor	User
Precondition	System User Model contains None User Knows that he can use system to search for informaton on CKD Wants to find out why and how he has to lower his blood pressure
Postcondition	System Has added to User Model: Need for Cognition, Knowledge about CKD, Education level. Has provided personalized information matching User's User Model User Knows that he can lower his salt intake to lower his blood pressure Has a more positive attitude towards lowering his blood pressure
Activity	1. User opens page with information on why he has to lower blood pressure 2. System shows questionnaires Need for Cognition, Knowledge about CKD, Education level 3. User fills in questionnaires 4. System calculates scores for Need for Cognition, Knowledge about CKD, Education level and stores in User Model 5. System shows information using either Strong Arguments or Affective Cues, depending on characteristics in User Model 6. User reads information 7. User answers questions about information to check whether he has understood information 8. User opens page with information on how he can lower his salt intake 9. System shows information using either Strong Arguments or Affective Cues, depending on characteristics in User Model 10. User reads information 11. User answers questions about information to check whether he has understood information
Requirements	REQ001, REQ002

5.3 Claims and Requirements for personalized BCS based on ELM

The situated Cognitive Engineering method offers a generic format to describe claims and requirements, to provide clarity and promote iterative development and reuse of previously validated claims (see Table 5.2 and Table 5.3). Requirements give a description of the functionality a BCS should offer, while claims provide testable hypotheses. Claims need always be connected to the Requirement they provide the justification for, need to be truthful and exclusive, and be concrete and testable. Furthermore, to assess the impact of requirements on operational use, upsides and downsides of claims need to be documented. For claims to prove adequate for incorporation in the requirements baseline, the trade-off between up- and downsides needs to be favourable towards the upsides. We have added fields for 'Validation' and 'Measurement' to provide a means to document whether the requirement has been validated before, and which measurements can be used in the validation of the requirement.

We have explained the theoretical consequences of how information needs to be presented to aid attitude formation according to the ELM in paragraph 5.1. The main challenge is the operationalization of these theoretical constructs in requirements for personalized BCS: how to implement the socio-cognitive factors ability and motivation to determine which information to present to match the mode of information processing in individual patients. Two corresponding claims regarding the functionality of BCS can be derived (see also Table 5.2 and Table 5.3):

1) Patients with a high ability and high motivation who receive persuasive information containing SA form strong and stable attitudes, but show no attitude change when receiving information containing AC.
2) Patients with a low ability or low motivation who receive persuasive information containing AC form weak and unstable attitudes, but show no attitude change when receiving information containing SA.

Figure 5.2 shows the hypothetical results we can expect from these claims, where T0 is attitude before receiving persuasive information, T1 is attitude just after receiving persuasive information and T2 and T3 represent attitude progress over time after receiving persuasive information.

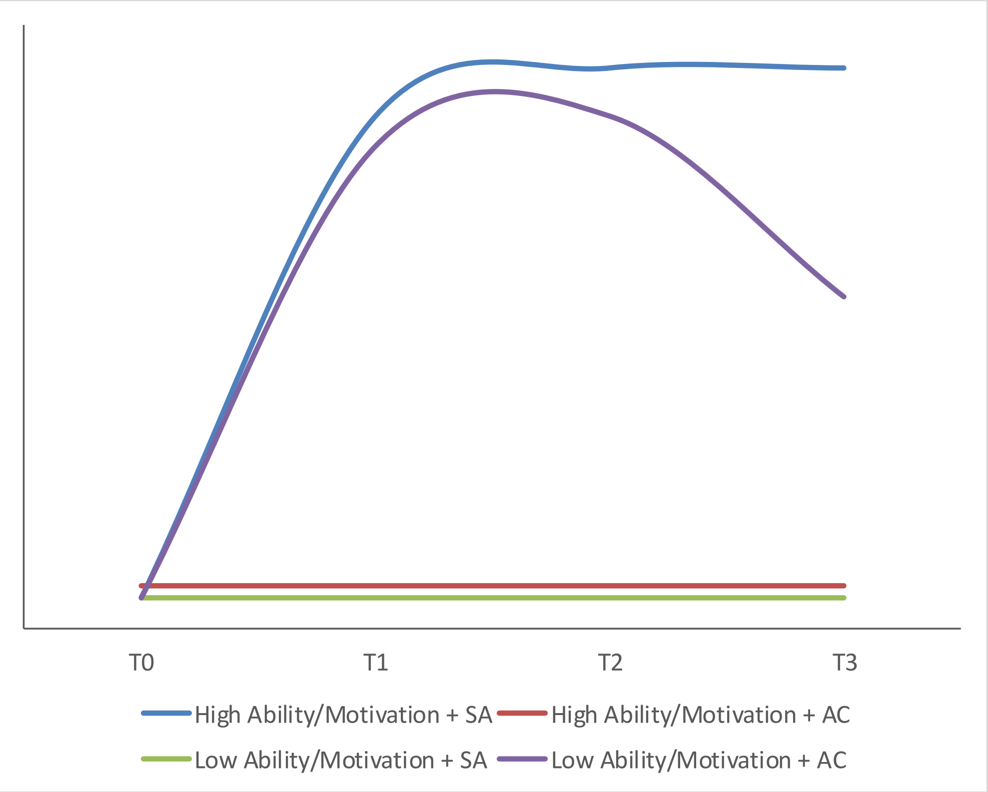

Figure 5.2 Hypothetical results to illustrate attitude change after receiving persuasive information for each combination of socio-cognitive factors and personalized persuasive behaviour. The y-axis represents attitude score, the x-axis time passed, where persuasive information is presented just before T1 and T2.

Two requirements for personalized BCS are thus to provide (1) strong arguments or (2) affective cues in persuasive information, based on users' ability and motivation to elaborate on information. Figure 5.2 also reveals the positive and negative implications when using SA and AC to persuade users to take action. Both can change attitude, but attitudes based on AC decrease over time or when encountering counter argumentation. Second, if users do not perceive the argument as strong, or the affective cue as affective (e.g. a source of the information that is perceived as untrustworthy), attitude change can be negatively affected.

Table 5.2 Requirement for providing Strong Arguments in BCS, specifying the Claim that justifies this requirement, positive and negative implications, if this claim has been validated before and which measurement can be used to validate this claim. Last, use cases that illustrate this requirement are specified.

REQ001	**A self-management support system shall provide strong arguments in persuasive information for users with a high ability and a high motivation to elaborate on information**	
Claim	Strong arguments increase persuasion when the receiver's ability and motivation to elaborate are high	
	+	Strong arguments can change attitude and enable formation of strong attitudes that are stable over time and resistant to counter-arguments
	-	Arguments that are not perceived as strong, have a negative impact on attitude change
	Validation	See Petty and Cacioppo (1986)
	Measure	Attitude before / after (/ follow up)
Use Cases	UC001	

Table 5.3 Requirement for providing Affective Cues in BCS, specifying the Claim that justifies this requirement, positive and negative implications, if this claim has been validated before and which measurement can be used to validate this claim. Last, use cases that illustrate this requirement are specified.

REQ002	**A self-management support system shall provide affective cues in persuasive information for users with a low ability or a low motivation to elaborate on information**	
Claim	Affective cues increase persuasion when the receiver's ability or motivation to elaborate are low	
	+	Affective cues can change attitude
	-	Attitudes formed based on affective cues are weak and decrease over time and during counter-argumentation Affective cues that are not perceived as affective, have a negative impact on attitude change
	Validation	See Petty and Cacioppo (1986)
	Measurement	Attitude before / after (/ follow up)
Use Cases	UC001	

5.4 Design Patterns for personalized BCS based on ELM

To design effective SA and AC and to be able to reuse design insights a methodological approach is necessary. sCE advocates the use of Design Patterns to lay down guidelines for design problems. Design Patterns contain premises that describe for which design problem they can be used, in which context they can be used, why the presented solution is optimal for the design problem and how the design solution should look. To our knowledge, such a methodological approach that enables incremental development of SA and AC has not been utilized before in developing personalized support for behavioural change. In the following paragraphs, we will describe the general design patterns for both strong arguments and affective cues in BCS.

5.4.1 Strong Arguments

The design problem for designing strong arguments is that first users need to recognize the strong argument, and second they need to understand and remember the information.

Deductive arguments are organized around a number of true facts and a conclusion that can logically be drawn from these true facts. We argue that properly designed argumentation has an innate strength, and arguments can be constructed that are universally seen as strong. Indeed, Hoeken, Timmers, and Schellens (2012) have found that there are a number of criteria that underlie the strength of reasoning in arguments. Information in BCS frequently makes use of analogies and consequences in argumentation. For arguments from analogy, Hoeken and colleagues found that arguments that contain no irrelevant similarities and no relevant differences between cases are seen as stronger. For arguments from consequences, they found that consequences that are desirable and probable make the argument stronger. Furthermore, arguments should contain a clear and logical reasoning, based on facts that support the probable truth of its conclusion. We have developed a method to systematically design arguments and organize message (including facts and conclusion), strong argument design (including argument type and consequences/analogy) and affective cue design (including source characteristics). This overview can be subsequently used by a copy editor to construct a message that is suitable for the intended audience (i.e. using understandable language). Table 5.4 shows an example of such a message.

Table 5.4 Example overview of reasoning for Strong Arguments message

TITLE: Hidden salt	
MESSAGE: 75% of the daily salt consumption comes from 'hidden salt' in prepacked food, e.g. instant meals, soups, bread, meats and cheese. By avoiding prepacked food, salt consumption can be reduced by 3 to 6 grams per day. Your blood pressure will lower when you reduce salt intake, which leads to a lower burden on your kidneys. Hence, the decrease of kidney function can be stabilized.	
Criteria	*Content*
True facts	1. 75% of the daily salt consumption comes from 'hidden salt' in prepacked food
	2. By avoiding prepacked food, salt consumption can be reduced by 3 to 6 grams per day
	3. Blood pressure can be lowered by reducing salt intake
	4. Lower blood pressure means a lower burden on the kidneys and less decrease of kidney function
Conclusion	By avoiding prepacked foods, decrease of kidney function can be stabilized
Positive message	If salt lower (+), then blood pressure lower (+)
Strong Argument	
Argument Type	Argument from consequences
Desirable consequence	Lower blood pressure
	Lower burden on kidneys
	Less decrease of kidney function
Probable consequence	Lower blood pressure
	Lower burden on kidneys
	Less decrease of kidney function

Second, to increase understanding and remembering the information, pictures that are closely linked to the information can be included to explain the information in further detail (Houts, Doak, Doak, & Loscalzo, 2006). Such pictures can for instance explain relationships between concepts or show statistical data that supports the arguments that are presented (see also the Design Rationale in Table 5.5). Table 5.5 presents the general design pattern for strong arguments.

Table 5.5 Design Pattern Strong Arguments, specifying whether this patterns has been validated, for which problem and in which context the pattern can be used, which premises underlie the pattern (rationale), and how the design should look like (design solution) including examples of the design. Last, related patterns are specified.

Name	Strong Arguments
Validation	Not tested
Design Problem (what)	User has to recognize strong argument in message about behaviour change, understand the message and be able to independently reproduce the message
Context (use when)	Suitable for users of self-management support systems
Design Rationale	A strong deductive argument presents a logical reasoning based on true facts that support the probable truth of its conclusion (Van Eemeren, 2003). A text message can aid to present the reasoning to the user. Graphical components that explain the message (e.g. cause-effect) can be used to enhance understanding and reproduction of the message (Houts et al., 2006). Understanding and reproduction of the message can be further enhanced by using both abstract and figurative graphical components to explain the message As source of message can act as an affective cue, strong arguments and graphical components should contain no reference to the source of the message
Design Solution (how)	*Modality* Text message combined with a chart or illustration that explains the message *Content and dialogue style* Arguments should contain positive facts towards healthy behaviour, formulated in a positive manner (Petty & Cacioppo, 1986) Arguments containing graphical support should refer to the graphic in the text Arguments should use understandable language, medical concepts should be explained or lay-man's terms should be used *Messenger* Self-management support system *Timing and repetition* Comprehension of and persuasion by complex messages can benefit from repetition of a message (Petty & Cacioppo, 1986) The system can ask the user a question about the message, or ask the user to reproduce the message, to determine whether the user understood the message and whether repetition is necessary Possibilities for repetition/timing: Two different messages can be used to convey the argument for short intervals One message can be used twice to convey the argument for longer intervals
Examples	Figure 5.3
Related Patterns	Affective Cues

In Figure 5.3 an example design of information containing Strong Arguments is presented. The information is written based on the argumentative structure given in Table 5.4 and concerns why patients with a chronic kidney disease need to lower their salt intake. On the right hand side of the information, a graphic is incorporated that explains the influence of salt intake on blood pressure and kidney function. Red and green colors are used to indicate respectively healthy and deteriorated kidneys. Both in the message and the graphic, lay men's terminology is used to explain medical information.

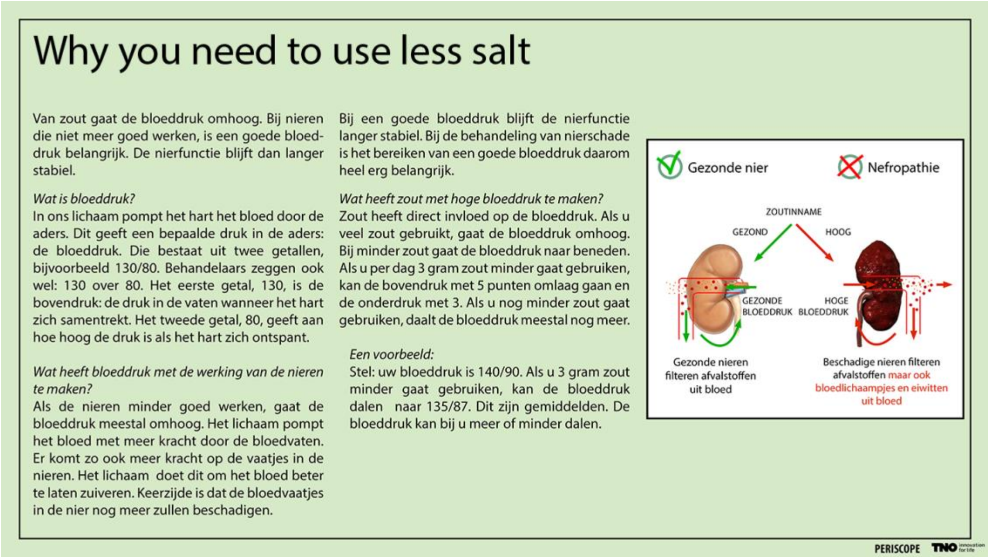

Figure 5.3 Example design Strong Argument, The text contains the argumentation and a picture is used to further clarify the text.

5.4.2 *Affective Cues*

The design problem for designing affective cues is first that the user has to recognize that the source of the message is credible and second the user needs to identify with the source by recognizing that the source is in the same situation as him or willing to help him.

Credibility of a source is determined by whether the source is recognized as trustworthy and an expert on the subject (see Pornpitakpan, 2004). Trustworthiness of sources can be indicated for instance by the profession of the source, or whether the source is in-group or out-group (Williams, 2001). Whether the source is an expert on the subject can be signified by adding a label, visual cue or documentation of accomplishment to the source. In the context of BCS, physicians for instance can be used to convey medical information. Physicians are seen as trustworthy, because of their profession and their interest to help patients. A label can be used to address the source as a physician, and a white coat and stethoscope can be used as visual cues that the source is a physician. Second, more practical information on dealing with the daily coping with a disease can be conveyed by fellow patients. Fellow patients are in the same group and same situation as patients that receive the information and are therefore seen as trustworthy. Because they are in the same situation and have the same problems and needs as the receiver of the information, they can also be seen as experts on the subject. Again, a label can be used to identify the source as a fellow patient, but also visual cues like a dialyser for dialysis patients can be used. However, by using people as sources, receivers of information can get distracted by the visual appearance of the source. For instance, when an elderly woman is used as source of information intended for a young man, the source can be misidentified as being out-group and thus not having the required expertise. To account for such possible distractions, when using people as sources, the source should be an abstract person, but still be clearly identifiable (see also Figure 5.4 for an example). As is the case for strong arguments, the design pattern (including examples, see Table 5.6) can be used by a professional designer (e.g. interaction designer) to develop the affective cues.

Figure 5.4 shows an example design of an Affective Cue. The information conveyed in this example is the same as the information in Figure 5.3, but in another shape. On the left hand side of the example, we see the same graphical explanation of the influence of salt intake on blood pressure and kidney function. Again, green and red colours are used to indicate healthy and deteriorated kidneys. The important message that needs to be conveyed in this example is stated by the physician. The example shows the abstract design of the source, while retaining the sense that the source is human and the visual cues that the source is a physician (white coat and stethoscope). In the lower right hand corner, a label stating his name and profession is used to indicate he is a physician with an expertise in chronic kidney diseases.

Figure 5.4 Example design Affective Cue, utilizing a nephrologist (indicated by a label) as a source and pictures to clarify the message.

Table 5.6 Design Pattern Affective Cues, specifying whether this patterns has been validated, for which problem and in which context the pattern can be used, which premises underlie the pattern (rationale), and how the design should look like (design solution) including examples of the design. Last, related patterns are specified.

Name	Affective Cues
Validation	Not tested
Design Problem (what)	The user has to recognize the source of a message to be credible and identify that source is in same situation as user.
Context (use when)	Suitable for users of self-management support systems
Design Rationale	Message and source can be presented in picture containing all information at once as people are familiar with having different kinds of information at once on a computer screen, when all information is present on screen, user can easily review information Video clip can be used to take user along through the information, and captures interest ('what comes next?'), but user can less easily review information Picture and video clip are an engaging (i.e. affective) way of presenting a message, this enhances persuasion for persons with low motivation or low ability to process a message Important in self-management systems (in contrast to e.g. advertisements) is that affective cues not only need to create affection, but also need to convey information A source is credible, when the source is seen by the user as (1) an expert on the topic of the message and (2) trustworthy (Pornpitakpan, 2004) Physician expertise can be indicated by label or visual cue, trustworthiness by profession Fellow patient expertise can be indicated by label, trustworthiness by being in-group
Design Solution (how)	*Modality* Use a picture or video clip to present source and message *Content and dialogue style* Message should lead user to identify with source, contain statements or visual information to show source is in comparable situation as user Message should contain statements about healthy behaviour Message should be presented in colloquial speech Message can be supported by clear icons to enhance understanding or emphasize emotion/sentiment Source's facial expression should match message (e.g. serious, happy) *Messenger* The messenger should make statements to which the user can relate and identify with messenger, show empathy To reduce influence of source appearance on identification, an abstract figure can be used to act as source Medical information or directives for healthy behaviour can use e.g. a physician or dietician as messenger (expert, trustworthy source (profession)) Tips and advice on how to practically manage daily hassles of a chronic condition can use a fellow patient as messenger (expert, trustworthy source (in-group))
	(table continues on next page)

	Timing and repetition Comprehension and persuasion by complex messages can benefit from repetition of a message (Petty & Cacioppo, 1986) The system can ask the user a question about the message, or ask the user to reproduce the message, to determine whether the user understood the message and whether repetition is necessary Possibilities for repetition/timing Two different messages can be used to convey the argument for short intervals One message can be used twice to convey the argument for longer intervals For a picture, scenes can be highlighted in consecutive fashion, or when user hovers with mouse to aid walk-through
Examples	Figure 5.4
Related Patterns	Strong Arguments

5.5 Conclusion & Discussion

In this chapter we have worked out the theoretical insights from the Elaboration Likelihood Model into Requirements for personalized BCS. The Requirements to provide strong arguments or affective cues determined by level of education, domain knowledge and need for cognition have been specified and are illustrated by a Scenario and Use Case, justified by Claims and shaped by Design Patterns.

Utilizing a methodological approach in designing functionality is beneficial for both development that is in progress, and future development of similar support systems. Requirements, Claims and Design Patterns can be reused when comparable Use Cases are encountered. Examples of this can be found in for example Peeters et al. (2012) and Mioch, Ledegang, Paulissen, Van Diggelen, and Neerincx (2014). The documentation of the validation of these Claims and Design Patterns enables an evidence based approach in the development of personalized information for BCS.

The Design Patterns and Requirements that have been developed in this chapter, however, still need to be validated in a real life setting. Therefore, in the next chapters we will report on a study into the feasibility of using these Design Patterns and Requirements in a BCS aimed at supporting chronically ill patients.

6 Feasibility Study Behavioural Change Support Prototype for Chronic Kidney Disease[8]

Summary

In Chapter 4, we identified the Elaboration Likelihood Model (ELM) as theoretical foundation for Behavioural Change Support (BCS) and in Chapter 5 we specified the corresponding Requirements, Claims and Interaction Design Patterns (i.e. Strong Arguments (SA) and Affective Cues (AC)). In this chapter we will describe an experiment set-up to test the feasibility of this personalized BCS.

Over the course of four weeks, we have measured attitude towards reducing salt intake of CKD patients after they have been presented messages containing either SA or AC. At baseline, the socio-cognitive factors that we measured were participants' level of education, knowledge about kidney disease and Need for Cognition to establish their motivation and ability to elaborate on information. During the course of the experiment, we have also measured the time participants spend to read the messages and fill out questionnaires and how relevant and credible participants find the messages. The research questions included exploring whether participants spend sufficient time reading the messages to understand and act upon these, whether instantiations of the Interaction Design Patterns yield credible and relevant messages and whether the measured socio-cognitive factors can be used to tailor this BCS.

[8] This chapter has been presented as:

Laverman, M., Neerincx, M.A., Alpay, L.L., & Schonk, Bertie J.H.M. (2013, September). *Using Human Factors to Tailor Persuasive Information in Self-Management Support.* Presented at Medicine 2.0'13, London, United Kingdom.

6.1 Integrating Requirements into a prototype to study feasibility

In Chapter 5 we have formulated the Requirements Baseline for personalized Behavioural Change Support (BCS). In this chapter we will describe the instantiation of these Requirements into a prototype BCS and the experimental set-up to study the feasibility of this design. The Requirements Baseline comprises of the Core Functions and the description of *when* these functions should be used (Use Cases), *why* these functions are utilized (Claims) and *how* these functions should look (Interaction Design Patterns, see Figure 6.1).

The prototype BCS concerns the use case of providing persuasive information to patients with a chronic kidney disease (CKD). One of the main life style changes these patients have to achieve to manage their disease is reducing their salt intake. Information to educate patients about reducing their salt intake is complex information, as it comprises both medical information about the influence of salt on blood pressure and kidney function, and practical information on how to change dietary habits to achieve a reduce in salt intake. Moreover, the information should persuade patients to actually act and change their behaviour. The Interaction Design Patterns are therefore instantiated into a number of persuasive messages regarding reducing salt intake, containing either Strong Arguments (SA) or Affective Cues (AC) as communicative strategy, which can be communicated to patients at various points in time. We have claimed in paragraph 5.3 (see Table 5.2 and Table 5.3) that using SA or AC appropriately can positively influence and strengthen patients' attitude towards reducing salt intake.

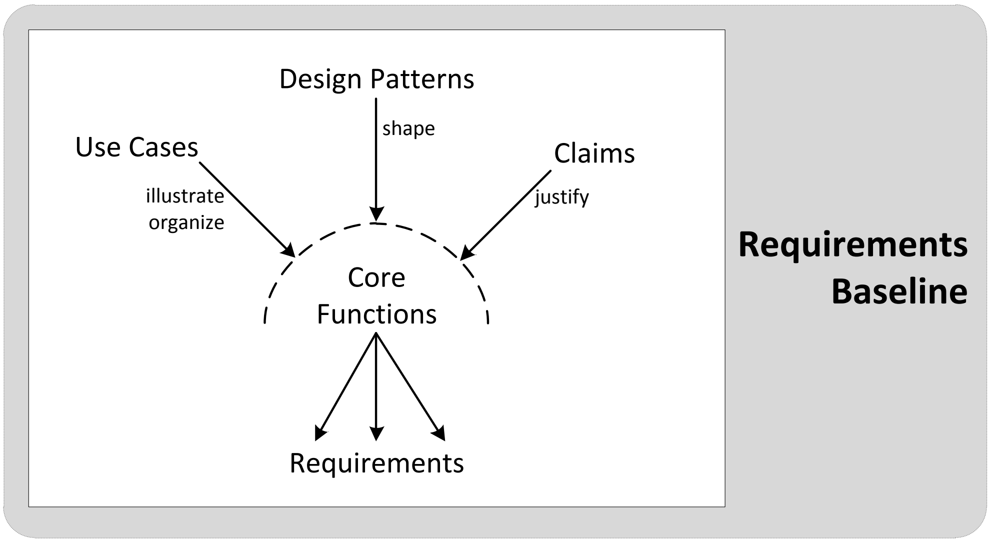

Figure 6.1 Overview elements Requirements Baseline

The study will explore the feasibility of this design on two levels, in line with the research questions specified in Chapter 1: the effectiveness of testing personalized information in an online prototype BCS and whether the design of personalized messages has effects on the attitude of participants. Therefore, we will first investigate the feasibility of measuring user characteristics and the use of these for determining the form of personalization. Do we see enough distribution in the measurements, and is there room for improvement in these characteristics (note that Need for Cognition and Education Level are relatively stable characteristics, whereas Knowledge can change over time). Second, to further test the design of personalized information we are interested in the effects of the personalized messages on attitude. These effects will be divided in main effects and interaction effects. For the main effects, we are interested in the change of attitude when persuasive messages are presented in SA and AC (our Claims) and the reliable measurement of participants' attitude. Furthermore, we will be looking into the premises of the Design Patterns: do users recognize the credibility of Arguments and Cues, do they have sufficient time to read and understand the messages, and is it feasible to break up these complex messages into multiple messages that are communicated at various points in time. For the interaction effects, we will explore the role that the user characteristics play in changing attitude with personalized persuasive messages. Can we evaluate the impact of the persuasive messages that are matched to users' characteristics on their attitude?

6.2 Instantiating Strong Arguments and Affective Cues for reducing salt intake

Two sets of persuasive messages regarding lowering salt intake, aimed at patients with a chronic kidney disease (CKD) were developed utilizing either SA or AC as communicative strategy. To decide what information should be conveyed through these messages, author ML collected a set of 22 statements referring to why CKD patients need to lower their salt intake (medical information) and how they can achieve this (practical information). These statements were derived from scientific literature, books and leaflets for CKD patients. These statements were scored by eight experts in the field of self-management and CKD on how convincing the statements were regarding reducing salt intake (Likert scale ranging from 1 'Not convincing' to 7 'Very convincing'). The three highest scoring statements for 'why' ($M = 6.00, 5.83, 5.33$; $SD = 0.63, 0.75, 1.63$) as well as for 'how' ($M = 5.50, 5.50, 5.50$; $SD = 0.84, 1.05, 1.38$) were used to construct the messages.

First, SA schemes were developed by authors ML and BS using the SA Design Pattern and the scheme from Table 5.4. The SA schemes were sent to an experienced copy editor who wrote the messages that were used in the experiment. The copy editor considered average literacy levels and use of lay man's terminology in writing the messages. Author ML subsequently designed figures to support the understanding of the SA messages. The messages and accompanying figures were drawn up into the final SA stimuli by an interaction designer from TNO, Soesterberg, The Netherlands (see Appendix C).

Subsequently, AC were developed by authors ML and MN according to the AC Design Patterns. These AC conveyed the same message as the respective SA, but utilizing either a physician (for medical information) or a fellow patient (for practical information) as a source of the information. Credible and likable sources are one of the strongest affective cues (Pornpitakpan, 2004). Prototype AC were drawn up by the authors, after which the interaction designer drew up the final AC stimuli based on these prototypes. The final AC were made more interactive by adding animation to guide the receiver through the different parts of the message. The final AC can be found in Appendix C.

6.3 Method

6.3.1 Participants

Patients with a chronic kidney disease (CKD) need to change their life style (e.g. restrict their salt intake to maintain a healthy blood pressure and keep their kidney function from deteriorating) to cope with their disease. Sixteen CKD patients were included in this study. One participant failed to finalize the first phase and did not respond to reminders to do so (see 6.3.2), this participant was consequently not invited for phase 2 and phase 3. A total of 15 participants did successfully finalize all three phases (12 female, 3 male; age 27-73 years old, mean 50 years old). At random, 8 of these patients received information containing strong arguments in favour of reducing salt intake (6 female, 2 male; mean age 48 years old), and the other 7 patients received information concerning reducing salt intake utilizing affective cues, i.e. a physician and a fellow patient as trustworthy source (6 female, 1 male; mean age 53 years old). A total of 15 participants is enough for formative evaluating how the tailored prototype works, whether participants encounter problems and serve as input for iteratively refining the prototype.

Patients were recruited via Nierpatiënten Vereniging Nederland [Association of Kidney Patients Netherlands] and local associations for kidney patients from the network of the authors. Information about the study was distributed to patients via the associations (email and Facebook), explaining the study and asking if they want to participate in a study that investigates what kind of information about restricting salt intake patients with CKD need. Participants were not dialyzing (CKD stages 1-3), had a good understanding of the Dutch language and had an internet connection at home. Participants were rewarded with a book voucher (€20) when they completed the study. Furthermore, the participants received a summary of the results of the study.

This research was reviewed by the Medical Research Ethical Committee of Utrecht University (protocol number 13/490), resulting in a positive decision by the committee.

6.3.2 Phases

Unfortunately, there has not been much research that focuses on attitude persistence. Most studies examine effects of persuasive messages immediately after message presentation. A line of research that does include longer periods between follow up measures is that of the *sleeper effect* (the effect that flawed affective cues in messages, e.g. a low credible source, can yield a positive increase in attitude when it meets a complex set of circumstances, see Pratkanis, Greenwald, Leippe, & Baumgardner, 1988). In this research, timing of reliable follow up measures has been between 2 and 5 weeks after the initial presentation of the message (Kumkale & Albarracín, 2004). We therefore opted to do a follow-up measure of attitude four weeks after the first presentation of our persuasive messages.

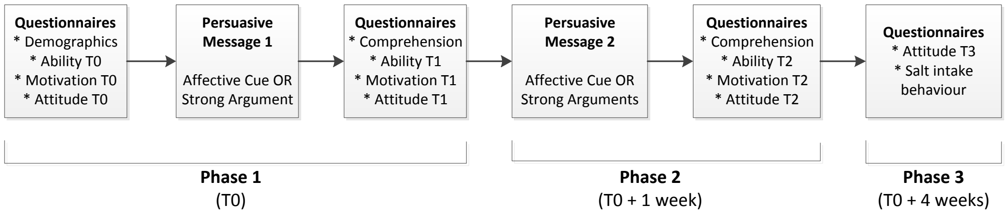

Figure 6.2 Phases in study. Phase 1 and 2 consisted of questionnaires and messages. Phase 3 consisted of follow-up questionnaires.

Figure 6.2 gives a schematic overview of the three phases of the study. Phase 1 consists of T0 and T1 and took place at participants' home. Participants received instructions and informed consent via email and were asked to carefully read the instructions and consent. They agreed with the instructions and consent via email and subsequently received information to login to the system to begin the experiment.

At T0, patients again received the instruction, and filled in questionnaires regarding demographics, ability and motivation to elaborate, and baseline attitude towards reducing salt intake (for a specification of all questionnaires see paragraph 6.3.3). Subsequently, they received the first set of persuasive messages. Afterwards (T1), attitude was measured again, followed by questionnaires regarding ability and motivation to elaborate. Total time of Phase 1 was approximately 30 minutes.

One week later (Phase 2, T2) patients were reminded by email to fill in Phase 2 of the study. The email contained a link to start the second phase, which they accessed from their home computer. Patients first received the second set of persuasive messages, after which they answered questions about their attitude, and ability and motivation to elaborate. The second phase took approximately 20 minutes to complete.

Four weeks after Phase 1, patients were reminded via email to participate in Phase 3. They again received a link to open the questionnaire from their home computer. Phase 3 consisted of a follow-up measurement for attitude (T3), and additionally participants were asked about their salt intake behaviour in the four weeks prior to T3 (i.e. the duration of the study).

6.3.3 Socio-cognitive factors Measurements

In paragraph 5.1 we have argued that level of education, knowledge of the domain and need for cognition can be used to determine people's ability and motivation to elaborate on information. We therefore used these factors as independent variables in this experiment. The complete questionnaires which are referred to below can be found in Appendix D. In a real life BCS these socio-cognitive factors would be part of the User Model and be used to decide whether to apply SA or AC for a specific user.

Education and knowledge were measured by two different questionnaires. Critical thinking is especially endorsed at higher education levels (e.g. González & Wagenaar, 2003). To distinguish between lower and higher education, we used a widely used standard classification of education level developed by Statistics Netherlands (Statistics Netherlands, 2011). There is currently no standard questionnaire measuring knowledge regarding restriction of salt intake. Therefore, we used a validated questionnaire measuring general knowledge about CKD: the Kidney Disease Knowledge Questionnaire (KDKQ; Wright, Wallston, Elasy, Ikizler,

& Cavanaugh, 2011). The KDKQ consists of 28 items regarding CKD. The score on the KDKQ equals the percentage of correct answers.

A validated questionnaire is available to measure Need for Cognition (Cacioppo, Petty, & Kao, 1984). In the experiment, the Dutch translation was used (Pieters, Verplanken, & Modde, 1987). The NfC questionnaire consists of 18 statements, which are scored on a 9-point Likert scale ranging from -4 (very strong disagreement) to +4 (very strong agreement). Total score is a sum of all 18 scores, and can range from -72 to +72.

Attitude was measured by the Semantic Differential Scale (SDS; Crites, Fabrigar, & Petty, 1994). The SDS is a validated questionnaire utilizing 19 word pairs (negative vs positive) to assess attitude. The SDS contains 8 affective word pairs, 7 cognitive word pairs and 4 general word pairs. Each word pair is scored on a 7 point Likert scale ranging from -3 to + 3. The score on the SDS is a summation of all 19 scores, and can range from -57 to + 57.

We checked distraction by asking participants to what extent they were distracted while they read the information (7 point Likert scale, from 0 'not distracted' to 6 'a lot distracted'). Personal relevance was checked by asking participants after they read the information to what extent they found it personally relevant (7-point Likert scale, from 0 'not relevant' to 6 'very relevant'). Furthermore, checked if participants read and understood the messages carefully by presenting three multiple choice questions regarding the information in the messages.

It is of interest for the development of self-management systems to check whether attitude change leads to changes in actual behaviour. We therefore included an extra question at T3 about salt intake behaviour during the course of the study, i.e. if people were more/same/less engaged with salt-intake and how.

6.3.4 Analysis

To analyze the feasibility of measuring user characteristics and using these to determine the form of personalization, we will look at how much time participants need to answer the respective questionnaires, whether the distribution of measurements (minimum versus maximum) is large enough and whether there is enough room for improvement on these characteristics (scores of participants versus maximum possible score).

We will analyze the design of personalized persuasive messages by investigating both main effects and interaction effects of the messages. Two main effects will be analyzed. First, based on the Claims specified in paragraph 5.3 (see also Table 5.2 and Table 5.3), we will look at the immediate (T1 and T2) and long term (T3) correlations between the SA and AC messages and participants' attitude (Pearson correlation, $\alpha = .05$). Both the SA and AC groups will be compared, as well as 'high' and 'low' able and motivated groups. Participants will be divided into 'high' and 'low' groups by taking the sample median scores for education, knowledge and Need for Cognition, and assigning participants to the 'high' group when their individual score is equal or higher than the median, and to the 'low' group otherwise. Second, related to the premises of the Interaction Design Patterns (see Table 5.5 and Table 5.6), we will analyze whether the time participants spend reading the messages has an influence on their attitude score and understanding of the messages (Pearson correlation, $\alpha = .05$), and whether participants recognize the credibility and relevance of the messages.

The interaction effects follow also from our Claims. We will analyze the influence of the measured user characteristics on the change of attitude when receiving personalized persuasive messages. Due to the formative nature of the study, we will analyze this influence by making use of distribution plots of participants' attitude scores at each T versus their user characterics (scores on education, knowledge and Need for Cognition).

6.3.5 Materials

The study questionnaires and messages were administered via the TailorBuilder software programme (http://www.tailorbuilder.com, OverNite Software, Sittard, The Netherlands). TailorBuilder is a web-based platform to construct questionnaires and personalised feedback. The personalised feedback in our study consisted of the messages in SA or AC format, depending on participants' study group. SA messages consisted of PNG images with a resolution of 8000 x 4500 pixels, scaled down to fit participants' internet browser viewport. AC messages consisted of Flash Video files and were also scaled to fit participants' internet browser viewport.

All questionnaires and messages were programmed as described in 6.3.2 and 6.3.3. Participants received log in information and a link to the log in page of the TailorBuilder programme from the study leader. All data was sent from the participants' home computer to the TailorBuilder webserver via secure connections, and saved in a secured database which was only accessible to the study leader. The TailorBuilder software also saved logs concerning the time participants took to answer the questionnaires and read the messages.

7 Results of Feasibility Study Behavioural Change Support Prototype

Summary

In this chapter we will present results from the experiment described in Chapter 6. The results show a large variation in both initial attitudes and attitude progression over the four weeks of the study. Participants were more inclined to read messages containing strong arguments as long as they deemed necessary, while messages containing affective cues were viewed for the duration of the animation. The results show that the messages have an impact on attitude, as long as participants take sufficient time to read the messages. Credibility of the arguments and sources of the message, and personal relevance of the messages was rated high by the participants. Despite the small sample size, the data already shows the potential of using socio-cognitive factors measurements to determine which communication strategy to use for which users.

We conclude that designing and validating a BCS prototype based on the Requirements Baseline provided in this report is a feasible approach to developing personalized BCS. We provide lessons learned and suggestions for further research in the concluding paragraph of this chapter.

7.1 Introduction

In Chapter 5 we have presented Requirements Baseline for personalized persuasive messages to support behavioural change and their rationale. Subsequently, we have described the instantiation of the Interaction Design Patterns and a feasibility study to investigate the implementation of these instantiations in a BCS prototype in Chapter 6. In this chapter we will present the results from the feasibility study in relation to the research questions described in paragraph 6.1.

7.2 User characteristics

7.2.1 Ability to elaborate

Ability to elaborate was measured by participants' level of education and their score on the Kidney Disease Knowledge Questionnaire.

Table 7.1 Level of Education for participants (N = 15)

Education level	N	%
Primary education (Basisonderwijs)	0	0
Secondary Education(VBO/MAVO/VMBO)	5	33
Secondary / Vocational Education (MBO/HAVO/VWO)	7	47
Bachelor's Degree (HBO/BSc)	3	20
Master's Degree (WO/MSc)	0	0

Education was normally distributed in this sample, but only three participants did receive a higher education (at least a vocational bachelor degree (HBO)). All of the participants completed secondary education.

The Kidney Disease Knowledge Questionnaire (KDKQ; Wright et al., 2011) consists of 28 items. The score for the KDKQ is determined by calculating the percentage of correct answers. The average score for our participants was 55% +/- 16% correct answers, the average is a little lower but the SD is comparable to Wright et al. (2011). The scores for both groups are comparable.

Table 7.2 Kidney Disease Knowledge Questionnaire scores of participants (N = 15). Possible score range is 0.00 to 1.00.

Group		Score
Strong Arguments	Average	0.50
	SD	0.16
	Range	0.29 – 0.79
Affective Cues	Average	0.62
	SD	0.14
	Range	0.43 – 0.75
Overall	Average	0.55
	SD	0.16
	Range	0.29 – 0.79

7.2.2 *Motivation to elaborate*

Motivation to elaborate is measured by participants' Need for Cognition, as measured by the Need for Cognition Scale (Cacioppo et al., 1984). The NfC Scale consists of 18 items, and score is determined by summing all 18 scores (range -72 to + 72). The mean score in the group of participants was 9.27, SD 18.56, range -21 to +46. These scores are not out of the ordinary, Sadowski (1993) found in his analysis of the NfC Scale (N = 1218, general population) a mean of 15.28, SD 21.46.

Table 7.3 Need for Cognition scores of participants (N = 15). Possible score range is -72 to +72.

Group		Score
Strong Arguments	Average	14.75
	SD	15.89
	Range	-8.00 – 46.00
Affective Cues	Average	3.00
	SD	20.58
	Range	-21.00 – 29.00
Overall	Average	9.27
	SD	18.56
	Range	-21.00 – 46.00

7.2.3 *Time to answer questionnaires*

An important aspect of using socio-cognitive factors measurements to determine personalization, is administering questionnaires to save these scores into a user model. To be practically usable, these questionnaires should not take too much time to not discourage users from using the system.

Figure 7.1 shows the average amount of time users need to answer each questionnaire. The demographics questionnaire (age, sex and education level) does not take much time to complete, on average about 20 seconds. More intricate questionnaires however take a lot more time. Participants needed about 3 to 4 minutes on average to complete the knowledge and need for cognition questionnaires. The first time the participants completed the attitude questionnaire took them about 2.5 minutes, but due to their familiarity with the questionnaire this time halved at the consequent measurements of attitude.

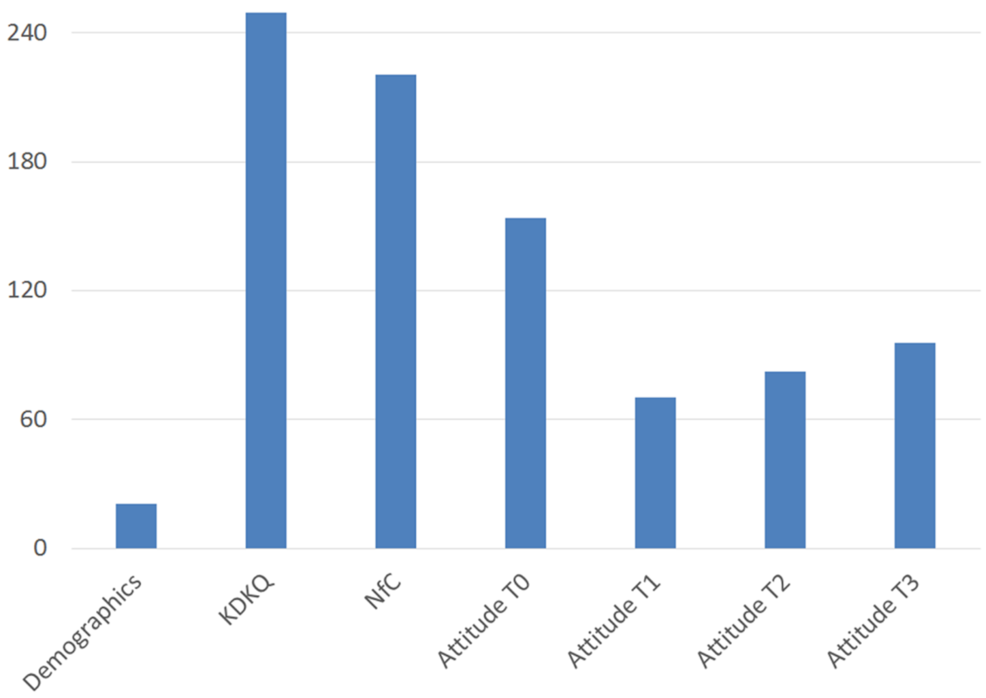

Figure 7.1 Time to answer questionnaires (in seconds)

Summarizing, measuring ability and motivation to elaborate on information using these measures yields scores that are comparable to previous research. Measurements were normally distributed and show enough spread to be usable in both research and development of personalized behavioural change. For knowledge of their disease, there is enough room for improvement. The time to answer questionnaires however does show a large variation. The attitude questionnaire is generally only used in a research context. The questionnaires for measuring user characteristics are needed in a real life BCS. The KDKQ and NfC questionnaires take relatively long to answer, as the questions in these questionnaires are more complex and need appropriate consideration before answering. The demographics questionnaire (containing Level of Education) on the other hand is very easy for participants to answer. We conclude that using these measures in behavioural change support is promising. Below we will further assess the main and interaction effects and whether these measures can be used to determine tailoring.

7.3 Main effects

Below we will discuss the results for the main effects of the persuasive messages. First we will analyze whether the Claims regarding the effect of personalized messages on participants' attitude scores have been met. Second, we will describe the results regarding the premises of the Interaction Design Patterns: whether the participants have sufficient time to understand the messages, whether they recognize the credibility of arguments and sources, and the perceived relevance of the messages.

7.3.1 Claims

Figure 7.2 and Figure 7.3 show the attitude scores (panels A) and reading times (panels B) for each participant in both the SA and AC group. A second distinction was made between participants that had a ‘high’ ability and motivation to elaborate on information, and participants that had a ‘low’ ability or motivation to elaborate on information. This distinction followed from the Claims; it was hypothesized that participants in the high group would be more influenced by messages containing SA, while participants in the low group would be more influence by messages containing AC. Participants were assigned to each group by calculating the median scores of education (2 – MBO/HAVO/VWO), KDKQ (54% of answers correct) and NfC (+8) (see also paragraphs 7.2.1 and 7.2.2). When participants’ individual score for each of these measurements was equal to or higher than the median, they were assigned to the ‘high’ group. When at least one of these measurements was lower than the median, they were assigned to the ‘low’ group.

The first thing that stands out in the attitude data from the Strong Arguments group is a large variation in individual attitude scores and progression over time. Although the participants show a short term reaction to the persuasive messages (T1 and T2 are measured directly after the presentation of the messages), we see different effects in the long term reactions (e.g. participants 104 and 118 show a less positive attitude at T3 when compared to T2). In the small sample, there is no difference in reaction to Strong Arguments between participants that are highly motivated and able and participants that are low motivated or able.

When we compare the Strong Arguments group to the Affective Cues group, we see less variation in attitude scores in the AC group. We see that all participants more or less have a higher attitude after the first set of messages (T1 compared to T0) and participants with a low ability or motivation show a stronger reaction to the AC. However, after the second set of messages, almost all participants show no or little change, except 105. This participant (105) does have a slightly high Need for Cognition. Comparable to the SA group, there is no clear change in attitude between in the long term (T3 compared to baseline T0).

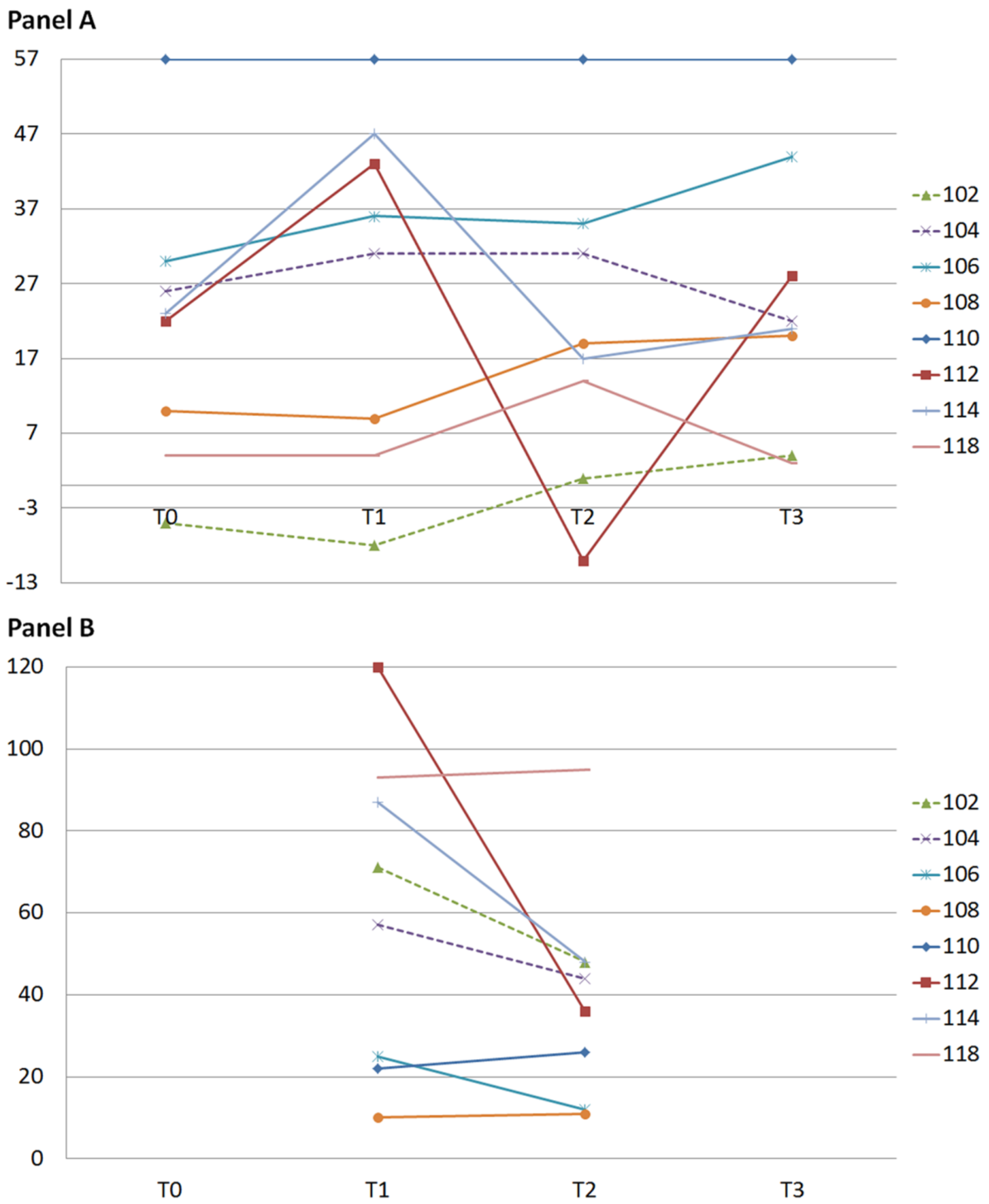

Figure 7.2 Attitudes (Panel A) and reading times (Panel B) in Strong Arguments condition. For panel A the y-axis represents attitude score, and for panel B time to read message in seconds. Each line and corresponding number represents one participant. Dashed lines indicate participants with high Ability and high Motivation, continuous lines indicate participants with low Ability or low Motivation.

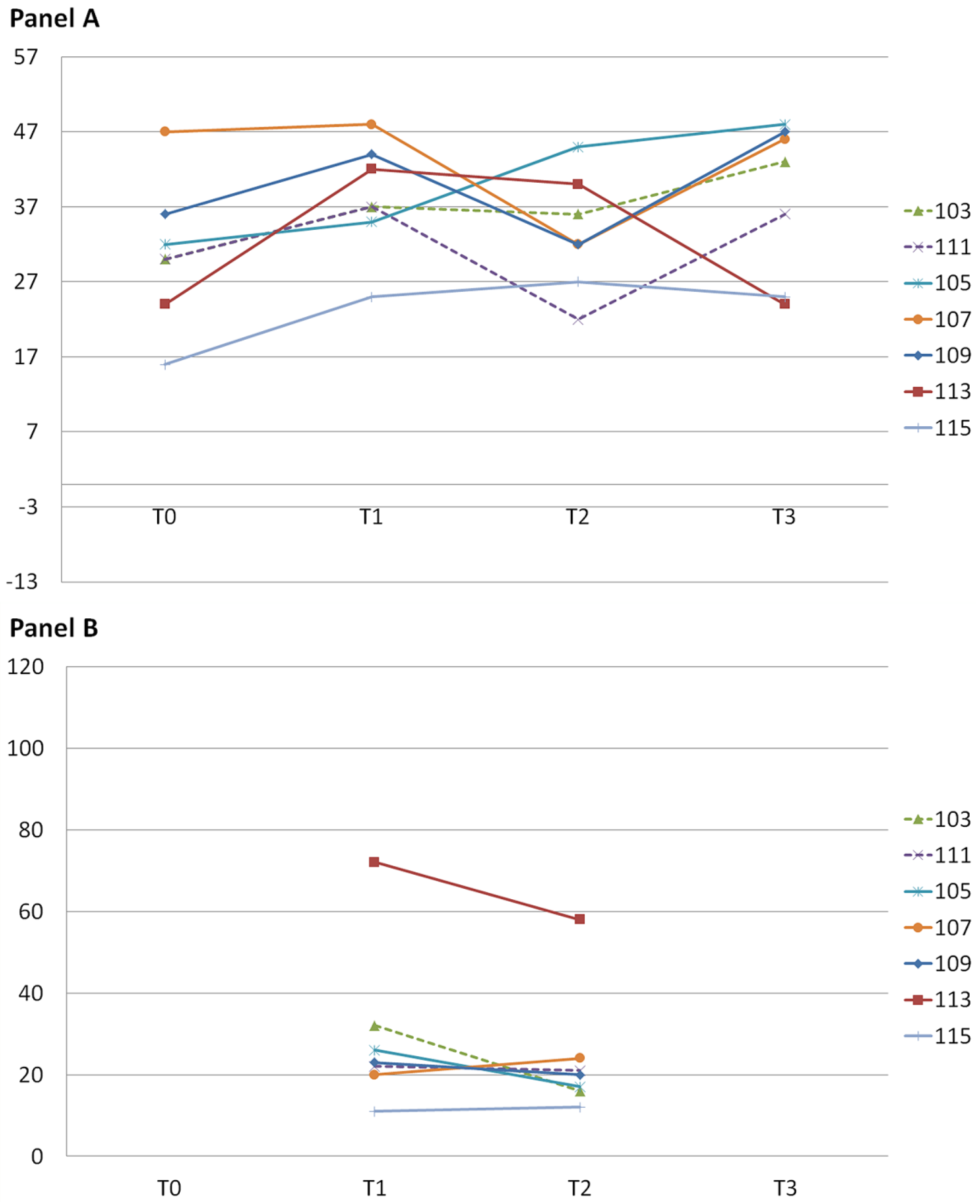

Figure 7.3 Attitudes (Panel A) and reading times (Panel B) in Affective Cues condition. For panel A the y-axis represents attitude score, and for panel B time to read message in seconds. Each line and corresponding number represents one participant. Dashed lines indicate participants with high Ability and high Motivation, continuous lines indicate participants with low Ability or low Motivation.

7.3.2 Premises Interaction Design Patterns

In the SA group, most participants take their time to read carefully through the messages, from about 40 seconds per message up to 90-120 seconds per message. If we compare reading times to attitude scores, the general trend is that if participants spend more time reading the messages, they have a more positive attitude after reading the message. This is most apparent at T2. Especially interesting in this regard are the scores from participants 112 and 114. Both show a large drop in attitude score at T2, and they both spent much less time reading the messages at T2. Both these participants have by far the lowest KDKQ scores (29% and 32% respectively). Furthermore, three participants have relatively fast reading times (around 20 to 30 seconds). One of these participants (106) found the messages not relevant (see also page 70). The reason for the fast reading times for the other two participants is unclear. This might be due to participants re-reading the messages (click back to first message and view them again), but unfortunately, the TailorBuilder software does not record this behaviour.

An interesting difference when comparing the AC group to the SA group is that the reading times for AC are almost the same for all participants, between 15 to 30 seconds. As the AC messages' animation was about 15 seconds in length, we infer that participants stop reading when they realize the animation has stopped, while participants in the SA group were more inclined to spend the amount of time they deem sufficient to read the messages. Furthermore, we see no effect of reading time on attitude score (Pearson Correlation = .331, p = .469 at T1 and Pearson Correlation = .332, p = .466 at T2).

Regarding the complexity of the information we found that all participants were able to correctly answer the multiple choice questions and read the messages at both points in time.

The average scores for relevance of the messages and credibility of the argument (SA) or source (AC) are high (scale 0 to 6). This means that participants did recognize the premises of the Interaction Design Patterns, i.e. that the information is relevant for them, and that the argument in the message is strong (SA) and the source of the information is credible (AC). Participants in the AC group found the information slightly more relevant than participants in the SA group. The difference between these two groups is largely due to one participant in the SA group, and this difference is reduced when this participant is left out of the analysis. This participant commented that she kept a blog about saltless cooking, and hence already knew the information in the messages. The credibility of argumentation (SA group) is comparable at both T1 and T2. The credibility of the source of the information (AC group) is slightly higher at T2 as compared to T1. Again, this is due to one participant which rated the credibility of the source at T1 0 out of 6. At T1 a nephrologist was used as source and at T2 a fellow patient. As the rest of the participants rated the credibility 6 out of 6, this participant might have made a mistake when answering this question.

Table 7.4 Perceived relevance and credibility of messages at T1 and T2 (N = 15). Possible score range is 0 to 6.

	Group	T1	T2
Relevance	Strong Arguments	4.50	4.13
	Affective Cues	5.14	4.57
	Overall	4.80	4.33
Credibility	Strong Arguments	4.88	4.50
	Affective Cues	5.00	5.43
	Overall	4.93	4.93

7.4 Interaction effects

The previous paragraph discussed the main effects of personalized persuasive messages on attitude. In this paragraph, we will discuss the interaction effects that follow from the Claims. We will analyze using distribution plots whether personalized messages that match user characteristics show a more positive attitude score.

In a larger scale study regarding the impact of personalized persuasive messages on attitude, analyses of variance need to be used to investigate which socio-cognitive factors have the greatest influence on determining whether to present SA or AC to users of behavioural change support. Due to the explorative nature of this study and its consequent small sample size, distribution plots can be used to make inferences about the influence of socio-cognitive factors on attitude scores for each communication strategy. We will present plots for attitude scores and level of education below to show this approach. The plots for knowledge and Need for Cognition scores can be found in Appendix E. Each point in these plots indicates one absolute Attitude score (i.e. one participant) at T0 (circles), T1 (triangles), T2 (squares) or T3 (diamonds). Y-axes represent absolute Attitude scores, and X-axes represent the scores for each human factor. The X-axis represents the Education Level: 0 = Basisschool; 1 = VBO/MAVO/VMBO; 2 = MBO/HAVO/VWO; 3 = HBO/BSc; 4 = MSc.

A clear difference in the trend of these plots can be seen (Figure 7.4), even though there is not much variation in education level in our small sample. In the SA condition (panel A), we see a positive trend: participants with a higher education generally have higher attitude scores. This is indeed what would be expected: participants with a higher ability to elaborate (i.e. higher education) prefer messages containing strong arguments. The opposite is true in the Affective Cues condition (panel B). The AC group shows a negative trend, that is, participants with a higher education have lower attitude scores. Again, this is what we expected, people with a lower ability to elaborate (i.e. lower education) prefer messages containing affective cues.

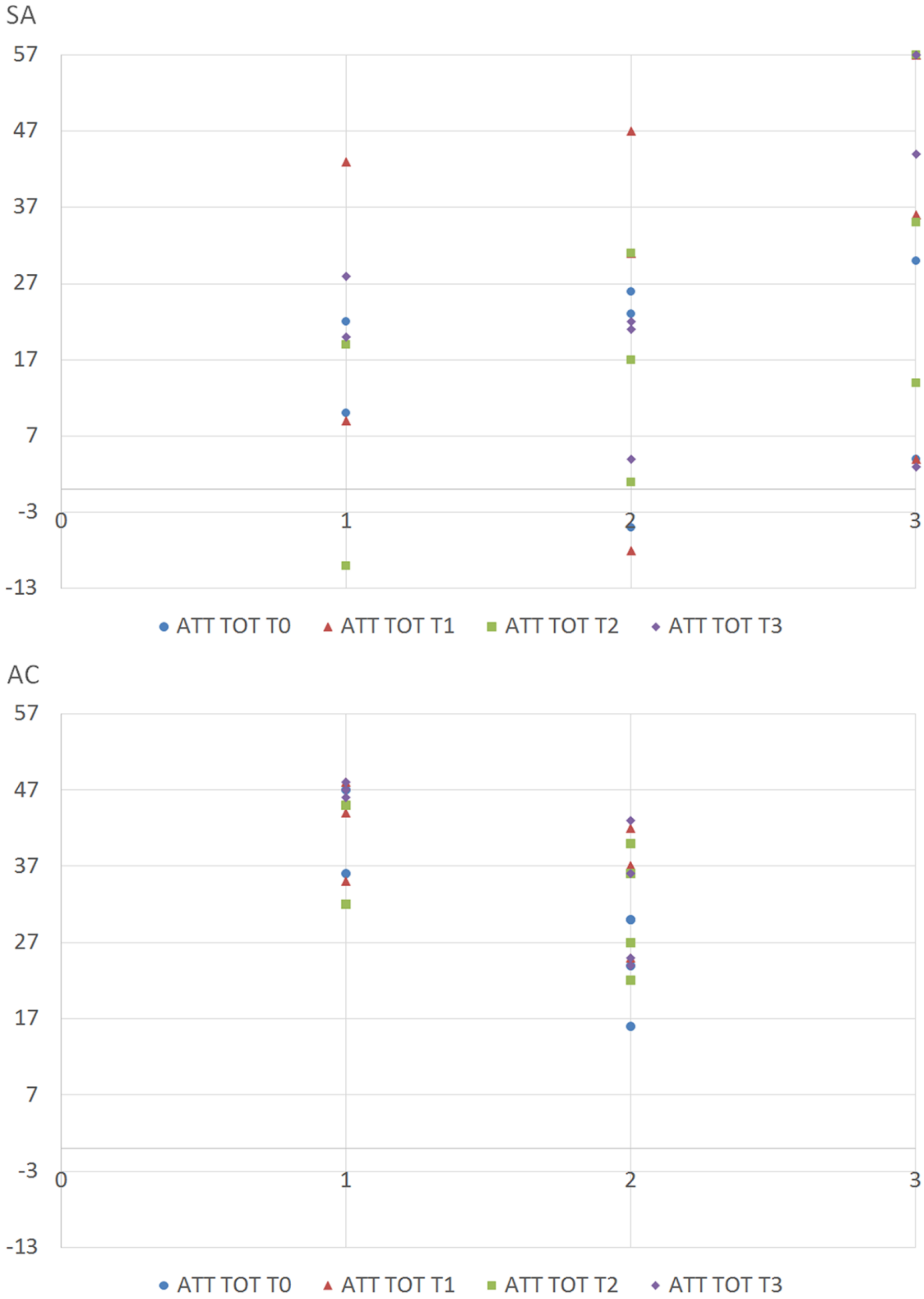

Figure 7.4 Attitude scores for Education level. Each point represents an absolute attitude score for one participant at one T. The y-axes represent attitude scores and the x-axes represent the level of education. The top panel shows the SA condition, the lower panel shows the AC condition.

7.5 Conclusion

The most apparent conclusion from the data of this feasibility study is the large variation in attitude scores and unclear relation between the ‘high’ and ‘low’ groups and attitude scores. For a large scale study it is therefore advisable to use sufficiently large number of participants to increase statistical power. These participants should be stratified into ‘high’ and ‘low’ ability/motivation groups at the start of the study to better investigate the impact of personalized messages on attitude scores and the underlying socio-cognitive factors.

As we have seen, our data indicates that taking sufficient time to read the messages has a more positive impact on attitude scores. This is expected in the light of the Elaboration Likelihood Model, after all, individuals need sufficient cognitive resources to be able to process the information. The AC in this study had animated elements, which had a duration of about 15 seconds. Participants stopped reading when the animation was over, which was not necessarily the moment they fully understood the message. This could be mitigated by clearly instructing participants to read the messages until they fully understand it. However, this is quite the ‘clinical’ solution: in a real-life setting, users just need to use such a support system, without extreme instruction. One possible practical solution would be to let the source in the AC ask the user a question regarding the most important issue of the message to check whether the user has fully understood the message, or show a pop-up message asking the user whether he is sure he understood the message for SA. Second, when studying reading behaviour of messages in a prototype, the system needs to record the when participants skip back or forth through messages, to recognize whether participants read information more than once.

The instantiation of SA and AC based on the Interaction Design Patterns was successful. Participants recognized the credibility of the arguments in the SA messages and the credibility of the source in the AC messages. We did see a difference in behaviour reading static text (our SA) and animation (our AC) which is important for instantiating Interaction Design Patterns. When using static text, users can take the time to read through the message until they have fully understood the message, and for instance easily read back or think about information. When using animation, users easily progress when they realize the animation is over, the focus is less on fully understanding the information. In our prototype, when the animation was over, all information was present on the screen. Other examples of animations or movies might not have all information at once on the screen. While there is benefit in offering a narrative and guiding the user through the information, users can less easily read back information, or stop and think about the information that was presented to them.

In this study we chose to take the complexity of information into account by presenting the messages to the participants at two points in time. When using a BCS however, most users will read such information all at the same time and may reread it when they feel it to be necessary. To better support users and personalize the information to users more research into complexity and repetition is necessary.

Despite the small sample size, we could see some trends in distribution plots regarding socio-cognitive factors measurements and attitude scores. It is important to include these in a large scale study, to be able to determine which of these socio-cognitive factors has the largest influence on the choice of communication strategy.

Ideally, a personalized behavioural change support system should contain only those socio-cognitive factors which have a large impact on choice of personalization strategy, and take into account the ease of measuring these socio-cognitive factors. For instance, if level of education and knowledge would explain the major part of variance, it is preferred to only ask users about their level of education, as adding extra factors makes the system more complex. After all, when users first have to take a lot of time to answer intricate questionnaires, they are easily discouraged to use such a system.

It is worth noting that more female participants than male participants applied to participate in the study. We did not ask participants for their reasons to enroll, but it could be possible that women are more inclined than men to volunteer for such studies (see e.g. Galea & Tracy, 2007), or to use such systems to manage their health (although a recent review found no gender differences in acceptance of consumer health IT, see Or & Karsh, 2009).

Summarizing our findings, we are positive about the feasibility of designing personalized BCS based on the Interaction Design Patterns formulated in Chapter 5. To be applicable in a real-life BCS, further investigation of which socio-cognitive factors are most valuable to determine personalization is needed.

8 Conclusions & Recommendations

In this report we have investigated the systematic development of personalized information for use in behavioural change support (BCS). First we have laid out the work domain and support opportunities by providing a functional model of BCS in Chapter 2, perspectives of users on BCS in Chapter 3 and the theoretical foundations of personalized information in Chapter 4. These insights were incorporated in a Requirements Baseline in Chapter 5. We have instantiated this Requirements Baseline into a functional personalized prototype BCS aimed at patients with a chronic kidney disease and studied the feasibility of this approach in Chapters 6 and 7 respectively. In sum, the report provided three main outcomes: (1) the functional model for personalized BCS, (2) an application of sCE methodology for developing personalized BCS, and (3) guidelines and tools to test claims on personalized information in BCS.

In paragraph 8.1 we will further elaborate on the conclusions and recommendations for personalized information. Then we will discuss the use of sCE as method for development of BCS in paragraph 8.2. In paragraph 8.3, we will consider the implications of using this method in practice. We will conclude with the constraints regarding the feasibility study (paragraph 8.4) and the general recommendations that follow from this report (paragraph 8.5).

8.1 Combined, dynamic and sensitive personalized information

Current behavioural change theories contain largely similar concepts and processes of behavioural change (see Chapter 4) which can be used to develop personalized BCS. There is, however, insufficient consideration of three important aspects of personalization of information: 1) the *combination* of different personalization techniques, 2) the *dynamic* nature of determinants of personalization, and 3) the *sensitivity* of personalization techniques.

The combination of different personalization techniques entails using multiple socio-cognitive factors as determinants for tailoring. For example, combining ELM based tailoring (SA and AC) with users personality (e.g. adding more positive messages when a user has a neurotic personality). There are numerous other examples to think of, e.g. combining textual and visual information, differentiating in depth of information based on Need for Cognition or utilizing users’ flow through the system based on clickstream data. Research in this area should focus on finding combinations of socio-cognitive factors that have a provable impact and are feasible to implement in BCS.

Some determinants of personalization can be dynamic over time. An example of this is the knowledge of patients’ disease: over time, patients increasingly gain knowledge about the causes, consequences and risks concerning their condition. When patients start using BCS and their knowledge is still low, using Affective Cues as personalization strategy can be advisable, while after a while incorporating more Strong Arguments as strategy can be more effective.

The personalization strategies discussed in this report, and currently developed in the field still contain few categories for personalized information. In practice, information is not processed in such demarcated processes (e.g. Osman, 2004), but rather in a spectrum with strategy A and B being the extreme ends of information processing. Personalization strategies should have enough sensitivity to cover a sufficient range of this spectrum. A straightforward application of this, for example in the case of persuasive information based on the ELM, would be to offer not only strategy A (i.c. Strong Arguments) and strategy B (i.c. Affective Cues), but also a combination AB (Strong Arguments with Affective Cues). This can be extended to options [A, AB, BA, B] and so forth. Investigations should be aimed at finding the minimum usable amount of sensitivity and as such offer the right option to match communication strategy to the right user at the right moment.

All three of these aspects of personalization are essential to offer effective personalization of information in BCS. However, these can not be realized all at once. It is necessary to incrementally investigate and formally evaluate these techniques in future research.

8.2 Methodic development of BCS using sCE

The sCE methodology has provided a promising approach in developing personalized BCS. The Work Domain and Support Analysis (see Chapters 2, 3 and 4) has lead to a reference model for developing personalized BCS. The functional model from Chapter 2 has been developed with both the scientific point of view and opinions of prospective users of such support systems (Chapter 3). The model gives guidance to developing support systems for behavioural change and shows which functions are essential for tailoring information and usability for patients that need to change their life style. The functional model includes the generic concepts and processes that are required to develop a personalized BCS, which can be adapted to specific behavioural change domains. Chapters 5 and 6 show that sCE can guide the development of a consistent and coherent requirements baseline, based on a sound empirical rationale, which can be tested and refined to incrementally develop BCS.

What is particularly an added value for the field of behavioural change support, is its focus on incremental and iterative development, utilizing previously validated insights and laying the foundations for future development. To date, this has been undervalued in BCS development. Furthermore, sCE advocates involving prospective users at all stages of development. In the self-management domain this is especially relevant as users will increasingly need to depend on such support systems in the future for their health care.

8.3 Methodology in practice

An important challenge in this study and in future development of BCS is the operationalization of theoretical insights into practical requirements and functionality for BCS. The translation of conceptual definitions into operational definitions is not as trivial as it may sometimes look like. The Elaboration Likelihood Model for instance offers a comprehensive conceptual model and definitions of how the design of messages can influence attitude, but how do ‘strong arguments’ and ‘affective cues’ actually look like? Which premises does designing such messages need to follow? How can we measure user characteristics in a usable manner to determine which form the messages should take? From the feasibility study we can conclude that the participants did recognize the premises that were specified in the

Interaction Design Patterns for Strong Arguments and Affective Cues. However, individual differences in the outcomes of processing the messages was evident. The specified Interaction Design Patterns should therefore be further refined and validated to be more sensitive to these individual differences and take into account enabling preconditions for processing the information (such as minimum time needed to sufficiently read messages).

8.4 Constraints of Feasibility Study

A limitation of our development of the personalized messages lies in a low involvement of the recipients of those messages. Although the participants in the study rated the messages highly relevant and credible, the messages were developed by involving experts in the field of self-management and renal diseases. Both experts and intended recipients should be involved in developing information for BCS. we have not validated these messages beforehand. One problem we encountered was the time participants spent reading the Affective Cues messages: we can not be sure whether 15-20 seconds is really sufficient to grasp the meaning of the message. When developing messages for BCS, the premises of design patterns need to be validated and boundary conditions such as the minimum time that is needed to grasp the message should be obtained.

8.5 Concluding remarks

The practical use of ICT applications to support behavioural change, now and in the future, is evident. The healthcare sector has slowly started to entrust patients with a greater freedom and responsibility concerning their care process and this will increasingly be propagated in the (near!) future. This does not mean a diminishing role of caregivers, but a changing role. Caregivers, patients *and* support systems will work together in the health care and maintaining quality of life of patients with chronic conditions.

It is therefore vital that BCS are as usable as possible. Usability in this sense is twofold. Interfaces of BCS need to minimize chances of erroneous use, as this can have direct negative impact on the health of users, and second the information in such systems needs to be understandable and persuasive, as patients are not trained caregivers (but learn along the way!) and by successfully changing their (life style) behaviours can greatly improve their quality of life.

Incremental and methodic development of BCS, based on empirical evidence is necessary to specify reusable design solutions. It is important that the rationale of the design identifies the applicable domain (e.g. specific chronic conditions or life style changes), to enable iterative development. To enhance collaboration between stakeholders and different scientific domains, sharing formal specifications in terms of use cases, requirements, claims and interaction design patterns is needed. This can enhance both the impact of socio-cognitive research as well as the effectiveness of BCS. Tools to enable this collaboration are being developed, for instance the Situated Cognitive Engineering Tool (http://www.scetool.nl) that supports the organization of the requirements baseline for support systems and the results of refinement and validation of these requirements.

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A Scenario Chronic Kidney Disease Self-Management

Piet is een 62 jarige man, gehuwd, vader van twee volwassen zoons, en onlangs opa geworden. Piet werkt fulltime als vertegenwoordiger van kopieerapparaten en is daardoor vaak onderweg. Piet rookt niet, maar houdt wel van een glaasje wijn en lekker eten op zijn tijd, mede daardoor is hij wel tien kilo te zwaar. Door zijn werk zit Piet veel in de auto, maar in het weekend maakt hij regelmatig een fietstochtje met zijn vrouw. Sporten doet Piet niet.

De laatste tijd heeft hij af en toe hartkloppingen en sinds een half jaar hoofdpijn. Drie weken geleden is KJ (de vader van een van de beste vrienden van zijn oudste zoon) plotseling overleden aan een hartinfarct terwijl hij nooit ziek was en kerngezond leek. Piet schrok zich hierdoor rot: KJ was slechts enkele jaren ouder dan hem en ook pas opa geworden. Piet realiseert zich hierdoor dat het niet vanzelfsprekend is van een gezonde oude dag te mogen genieten en hij maakt zich zorgen over de hartkloppingen.

Piet consulteert zijn huisarts met deze zorgen, die tot grote schrik van Piet een fors hoge bloeddruk constateert en een gestoorde nierfunctie. ‘Dat klinkt niet goed, maar wat betekent het nu eigenlijk?’ denkt Piet. Voor nader onderzoek verwijst hij Piet naar de internist. In het ziekenhuis wordt bloed afgenomen en hij moet urine inleveren. Het blijkt dat er in zijn urine iets eiwit zit en er te veel zout in zit. Zijn nieren functioneren daarbij nog voor 60%,vertelt de internist hem. ‘Oei!’, denkt Piet, ‘dat is een flinke afname.’ Er zijn geen andere afwijkingen gevonden, behalve een ietwat verhoogd cholesterol. Maar, zo heeft de internist hem duidelijk gemaakt, als de bloeddruk zo hoog blijft dan is de kans op complicaties groot. De hoge bloeddruk is een risico voor verdere nierfunctieachteruitgang en voor het ontwikkelen van hart en vaatziekten, zoals bv een hart of herseninfarct. De internist geeft aan te willen starten met medicijnen, maar vertelt Piet dat hij door zijn zoutgebruik te beperken en af te vallen zeker iets zelf aan zijn bloeddruk kan doen. Ook vertelt hij dat Piet, wanneer zijn nierfunctie verder achteruit gaat, heel goed op bepaalde voedingsstoffen moet gaan letten.

Van de internist heeft Piet een aantal folders met informatie meegekregen. Deze leest hij door en hij zoekt ook op internet naar meer informatie over hoge bloeddruk. De informatie die hij vond bestond vooral uit medische afbeeldingen en medisch inhoudelijke informatie. ‘Het is een ware sluipmoordenaar’ vond hij op een website . Piet moest meteen aan KJ denken, zou die ook hoge bloeddruk hebben gehad? Piet is vastbesloten om wat aan die hoge bloeddruk te doen, en dat kan ook, zo heeft hij begrepen van de internist en gelezen op het internet. Piet wil graag met zijn kleinzoon leuke dingen kunnen ondernemen en fietsen zodra hij stopt met werken over 3 jaar. Ook houdt hij ervan om samen met zijn vrouw lekker te koken en uitgebreid te tafelen met vrienden, dit wil hij niet missen. Hij wil het goed aanpakken. Piet heeft al vaker geprobeerd wat af te vallen en meer te bewegen, maar dat is lastiger gebleken dan hij aanvankelijk dacht. Maar nu is het echt nodig om actie te ondernemen, vindt hij, maar hoe? Via internet vindt hij weinig concrete praktische informatie, alleen algemeen advies.

Daarom maakt Piet een nieuwe afspraak met de internist. Deze adviseert hem om meer te bewegen en af te vallen en te letten op wat hij eet en vooral te proberen de hoeveelheid zout en verzadigde vetten te beperken. Dit betekent dat hij en zijn vrouw moeten gaan letten op wat ze eten en dat ze een nieuwe routine aan moet leren wat betreft hun voedingsgewoontes. De internist raadt hem aan hiervoor een ‘zelfmanagement systeem’ (ZMS) te gebruiken en adviseert hem het systeem waaraan het ziekenhuis heeft meegewerkt. Dat zit goed in elkaar. Van de internist krijgt Piet ook een informatiefolder over het ZMS. Via het ziekenhuis kan Piet ook een bloeddrukmeter aanschaffen, zodat hij zelf zijn bloeddruk kan meten.

Piet is gemotiveerd om te proberen zijn bloeddruk te verlagen en hij wil ook proberen dat zonder medicijnen te doen. Pillen slikken wil Piet alleen als het echt niet anders kan, want hij zit niet te wachten op de bijwerkingen die hij leest op internet. Het ZMS kan hierbij als een soort elektronische coach (e-coach) functioneren en de internist heeft Piet verteld dat het ZMS misschien iets voor hem is. Het is beschikbaar op het internet en via het webadres dat de internist hem heeft gegeven zou hij aan de slag moeten kunnen, zo zegt de internist. Piet is benieuwd of dat inderdaad zo is. Op zaterdagmiddag kruipt hij achter de computer en typt in: www.gezondinzicht.nl

Piet opent de website en hij ziet wat de website hem te bieden heeft wat betreft het bijhouden van zijn voedingsgewoontes. Hij ziet dat hij kan invullen wat hij dagelijks eet en overzichten kan krijgen van de voedingsstoffen die hij binnenkrijgt. Ook kan hij veel informatie opzoeken over wat er nu precies in allerlei voedingsmiddelen zit. Hij ziet dat je ook een filmpje kunt zien met een demonstratie van het ZMS. Piet leest de informatie en bekijkt het demonstratiefilmpje. Hij ziet hoe iemand via het ZMS invoert wat hij elke dag eet en dat de website een overzicht laat zien hoeveel calorieën, zout, vet en een aantal andere voedingsstoffen de persoon binnengekregen heeft. Ook ziet hij dat het ZMS informatie over alternatieve voedingsmiddelen en praktische tips en advies kan geven. ‘Dat is makkelijk!’, denkt Piet en hij besluit een account aan te maken.

Wanneer hij een account aangemaakt heeft en zijn persoonlijke informatie heeft ingevuld, komt hij direct op zijn persoonlijke pagina in het systeem. Piet ziet dat hij via zijn persoonlijke pagina alle functies van het ZMS kan bereiken, zoals een doel stellen, invoeren wat hij heeft gegeten en een overzicht krijgen van wat hij dagelijks aan voedingsstoffen en calorieën heeft binnen gekregen. Ook is er veel informatie over hypertensie (hoge bloeddruk) te vinden. Piet heeft op internet wel wat gelezen over wat hij kan doen aan zijn hoge bloeddruk, maar hij wil toch eerst de informatie in het ZMS eens doorlezen om zelf te bepalen waar hij het beste aan zou willen gaan werken. De internist heeft aan het ZMS meegewerkt, dus hier zal wel betere informatie staan dan op het internet, denkt Piet. Daarom besluit hij eerst de informatie pagina’s te openen, via deze pagina’s kan hij informatie en veel gestelde vragen over hoge bloeddruk vinden. De website vraagt Piet of hij wat meer informatie over zichzelf wil invullen, zodat hij informatie speciaal voor zijn situatie kan krijgen. Dat doet Piet liever niet, ‘ik wil niet m’n hele hebben en houwen invullen, hoor!’

Piet leest op de informatiepagina welke factoren er een rol spelen bij een hoge bloeddruk. Piet leest dat het verlagen van zijn bloeddruk op verschillende manieren kan en dat dit voor iedereen verschillend kan zijn. ‘Dat wist ik nog niet,’ denkt Piet, ‘waar zou ik het beste mee kunnen beginnen?’ Piet leest dat zout eten, overgewicht, weinig beweging, en het eten van drop allemaal slecht zijn voor zijn bloeddruk. Piet gebruikt tijdens eten vaak zout, en ook een frietje op zijn tijd houdt hij van. Maar, als dit hem helpt zijn bloeddruk te verlagen, dan wil hij dit echt wel veranderen. Al is het alleen maar zodat hij nog lang met zijn kleinkinderen wat leuks kan gaan doen en samen met zijn vrouw met vrienden uit eten kan gaan. Piet ziet het niet zitten om af te vallen, want zo dik is hij toch niet? En sporten? Piet brengt liever zijn vrije tijd door met zijn vrouw, vrienden en kleinkinderen. Piet roept zijn vrouw: ‘kijk eens wat ik allemaal kan doen om wat aan die bloeddruk te veranderen’ zegt hij. ‘Sporten en afvallen? Je bent al zo veel van huis voor je werk! En laatst heb je nog je enkel verzwikt’, zegt ze, ‘misschien moeten we proberen minder zout te eten, ik las in de krant dat Nederlanders veel te veel zout eten’ Piet vindt dit een goed plan. Hij klikt daarom op ‘minder zout eten’ en het ZMS raadt hem aan hiervoor een doel in te voeren.

Piet gaat aan de slag met het ZMS, meteen maar een doel stellen dan, denkt hij. Het ZMS geeft bij het invoeren van een doel voor zout eten ook direct een aantal tips. ‘Als je niet precies weet hoeveel zout je binnenkrijgt op een dag, vul dan eens een aantal dagen achter elkaar in wat je allemaal eet. Om wat je binnen krijgt aan zout te kunnen vergelijken met een doel kun je als je verder gezond bent maximaal 2400 mg per dag als doel stellen. Dit is de richtlijn voor gezonde voeding.’ Piet weet inderdaad niet precies hoeveel zout hij per dag eet. ‘Laat ik dat eens invullen en dan de komende week eens kijken hoe het gaat’, denkt Piet. Hij vult daarom 2400 mg in en selecteert volgende week zaterdag als dag waarop hij dat wil evalueren. Het ZMS geeft Piet hierbij nog een advies: ‘Gemiddeld krijgen Nederlanders ongeveer 4800 mg zout per dag binnen, het kan dus zijn dat ook u boven de richtlijn zit met zoutinname. Dit is niet erg, het is juist de bedoeling dat u leert waar veel zout in zit, zodat u dit kunt aanpassen. Via uw dagboek kunt u zien in welke voedingsmiddelen veel zout zit.’

Elke dag voert Piet nu in het ZMS in wat hij eet, hij merkt dat het nog best lastig is om ’s avonds te herinneren wat hij de hele dag gegeten heeft. De kopjes koffie en koekjes bij klanten zijn het lastigst om te onthouden, die vergeet hij soms wel eens. Hij meet ook elke dag zijn bloeddruk op en voert die in, hij is erg geïnteresseerd in hoe zijn bloeddruk er voor staat en heeft juist daarom de bloeddrukmeter aangeschaft. In het ziekenhuis heeft hij geleerd hoe hij de bloeddrukmeter kan gebruiken en ook in het ZMS is er een film met uitleg over het gebruik van de meter. Zo kan hij altijd even opzoeken hoe hij de bloedrukmeter moet gebruiken en hoe hij de metingen moet interpreteren. Op zijn persoonlijke pagina ziet hij ook een overzicht van de laatste vijf metingen van zijn bloeddruk en hoeveel zout hij binnen heeft gekregen op de vijf laatst ingevulde dagen. ‘Zo kan ik in één oogopslag zien hoe ik er voor sta’, denkt Piet. Als hij op dit overzicht klikt, krijg hij een uitgebreider overzicht van de hoeveelheden voedingsstoffen die hij binnen gekregen heeft en zo kan hij ook zien welke voedingsmiddelen veel zout bevatten. Het ZMS kan dit ook voor een bepaalde periode in een grafiek laten zien.

Nadat Piet een week zijn zoutinname in de gaten heeft gehouden, gaat hij via het ZMS kijken hoe hij er voor staat. Op zaterdagmiddag vult hij in wat hij tijdens de lunch heeft gegeten en vraagt dan via het ZMS een overzicht op van hoe veel zout hij de afgelopen week heeft binnen gekregen. Gisteren is het hem gelukt om niet meer dan 2400 mg zout binnen te krijgen zo ziet hij, maar vandaag heeft hij al aardig wat zout gegeten en hij en zijn vrouw gaan vanavond ook nog uit eten met vrienden… Ook krijgt hij wat te veel calorieën binnen en zijn bloeddruk is niet veel veranderd. Hij ziet dat ook de fosfaten en eiwitten waar de internist het over had in het overzicht staan, met een streefwaarde voor gezonde mensen. ‘Wacht eens,’ denkt Piet, ‘als ik invul dat mijn nierfunctie minder is, dan kan ik ook zien of ik misschien teveel eiwitten en fosfaten binnen krijg. .’

Het ZMS geeft aan dat Piet gisteren onder de 2400mg gebleven is. ‘Gefeliciteerd!’ staat er bij. Piet is best trots dat het gelukt is en laat het ook aan zijn vrouw zien. ‘Dat is mooi’, zegt ze, ‘maar we moeten nu wel volhouden!’ Piet is ook redelijk tevreden en zegt, ‘De komende week ga ik proberen elke dag niet meer dan 2400 mg zout te eten, misschien lukt het zelfs wel dat nog wat verder te verlagen.’ Piet’s bloeddruk is niet zo veel veranderd, maar de internist had hem ook verteld dat dat wat langer kan duren. Piet is erg benieuwd hoe deze zich de komende tijd ontwikkeld.

Piet vindt het wel lastig om zo op zijn zoutgebruik te letten. Zijn vrouw kookt namelijk altijd de hoofdmaaltijd en Piet vindt het zelf altijd leuk om toetjes te maken. Ze moeten dus samen uitzoeken hoe ze de maaltijd inrichten zonder te veel zout binnen te krijgen. Zijn vrouw kookt nu zoveel mogelijk zoutloos en doet dan zelf op haar portie wel wat zout. Gelukkig krijgt Piet bij het overzicht van zijn metingen ook tips en advies over alternatieve producten en recepten van het ZMS, zo heeft hij al een aantal lekkere zoutloze recepten gevonden samen met zijn vrouw. Door de tips en adviezen komen ze er achter welke producten veel zout bevatten en welke vervangende producten ze kunnen gebruiken. In het ZMS staan ook tips en adviezen van lotgenoten. ‘Wat handig, denkt Piet, ‘die andere mensen hebben al meer ervaring dan ik, die tips van hen sluiten goed aan bij de dagelijkse problemen waar ik ook tegenaan loop!’ Dit helpt Piet en zijn vrouw een nieuwe routine te ontwikkelen. Dat ze ook zonder zout heerlijk kunnen eten wisten Piet en zijn vrouw nog niet. Het is wel veel werk om elke dag iets nieuws te bedenken voor het eten, en ze merken dat ze soms toch ook een lekker hartige stamppot koken. Via het ZMS leest Piet dat ook andere mensen dit lastig vinden en dat zij een aantal standaard dagmenu’s hebben samengesteld. ‘Laten wij dat ook eens proberen’, zegt Piet tegen zijn vrouw, ‘en dan kunnen we in het weekend steeds wat anders koken, want dan hebben we genoeg tijd om lekkere recepten uit te zoeken.’

Via het ZMS kan hij ook zijn ingevoerde waarden delen met zijn internist of de diëtist. Soms twijfelt Piet wel eens over bepaalde voedingsmiddelen of maakt hij zich zorgen over zijn meetwaarden, bijvoorbeeld dat zijn bloeddruk nog niet zo veel veranderd is. Hij kan advies en feedback krijgen van zijn zorgverleners, zowel tijdens een bezoek aan de diëtist of internist, of via de berichtenfunctie in het ZMS zelf. Bij een bezoek aan het ziekenhuis kijkt hij samen met de zorgverlener in het ZMS hoe hij er voor staat. Maar het duurt nog een aantal weken voordat hij weer een afspraak in het ziekenhuis heeft en hij wil toch graag weten of het wel goed zit met zijn bloeddruk. Daarom stuurt hij een bericht aan de internist. In de folder had Piet gelezen dat hij dan binnen een week antwoord kan krijgen. De internist heeft het natuurlijk druk, maar , zo was hem verteld, bij dringende vragen zijn er ook altijd verpleegkundigen die het bericht kunnen beantwoorden. Zo heeft hij toch de zekerheid dat hij geholpen wordt als er iets aan de hand is.

B Use Cases

Overview

UC001.0 Account voor systeem aanmaken

UC002.0 Kennismaking: 1e gebruik systeem

UC002.1 Herhaald gebruik systeem

UC003.0 Invullen van vragenlijsten t.b.v. User Model

UC004.0 Probleem bepalen

UC005.0 Doel stellen en plan maken

UC006.0 Zelfmetingen bij doel invoeren

UC006.2 Overzicht van zelfmetingen opvragen

UC007.0 Feedback op zelfmetingen m.b.t. een doel

UC001.0	**Account voor systeem aanmaken**
Aanleiding	Gebruiker hoort van het systeem, gaat naar de homepage en wil weten of hij het kan gebruiken
Actoren	Gebruiker
Preconditie	Geen
Postconditie	Systeem: Account aangemaakt; Demografie in UM opgeslagen Gebruiker: Account aangemaakt; Kan beginnen met het opvragen van informatie over leefstijlverandering en de werking van het systeem
Beschrijving Activiteit	Via Homepage: 1. Gebruiker is op Homepage en klikt op *Maak Account* 2. Gebruiker vult accountnaam, wachtwoord en korte demografische vragenlijst in en klikt op *Maak Account* 3. Gebruiker wordt doorgestuurd naar Beginpagina met uitleg over systeem, algemene informatie over leefstijl verandering en mogelijkheid om direct met het systeem aan de slag te gaan (*Direct Beginnen*)

UC002.0	**Kennismaking: 1e gebruik systeem**
Aanleiding	Gebruiker heeft account aangemaakt, maar weet nog niet hoe het systeem werkt.
Actoren	Gebruiker
Preconditie	Parameters uit UM: Demografie (naam)
Postconditie	Systeem: Aandoening in UM opgeslagen; Gebruiker komt voortaan na inloggen op Persoonlijke Pagina i.p.v. Beginpagina Gebruiker: Begrijpt hoe het systeem werkt; Komt voortaan na inloggen op Persoonlijke Pagina
Beschrijving Activiteit	Via *Maak Account*: 1. Gebruiker komt op Beginpagina na account aangemaakt te hebben 2. Systeem haalt *Naam* op uit UM 3. Systeem begroet Gebruiker met naam en vraagt voor welke aandoening Gebruiker Systeem wil gebruiken 4. Gebruiker selecteert *Aandoening* 5. Systeem slaat *Aandoening* op in UM en toont informatie over hoe het systeem werkt 6. Gebruiker klikt op *Beginnen* 7. Systeem slaat *Introductie Voltooid* op in UM 8. Gebruiker komt op Persoonlijke Pagina met informatie over aandoening

UC002.1	**Herhaald gebruik van systeem**
Aanleiding	Gebruiker komt terug op homepage en wil verder werken met het systeem
Actoren	Gebruiker
Preconditie	Parameters uit UM: Demografie, Aandoening
Postconditie	Systeem: Gebruiker ingelogd Gebruiker: Gebruiker ingelogd
Beschrijving Activiteit	1. Gebruiker opent homepage 2. Gebruiker klikt op Inloggen 3. Systeem toont pop-up waar gebruiker zijn gebruikersnaam en wachtwoord in kan vullen 4. Gebruiker vult gebruikersnaam en wachtwoord in en klikt op inloggen 5. Gebruiker komt op Persoonlijke Pagina

UC003.0	**Invullen vragenlijst t.b.v. User Model**
Aanleiding	Gebruiker komt op pagina waarbij informatie getailored kan worden aangeboden, Systeem registreert dat benodigde parameters in UM niet aanwezig zijn
Actoren	Gebruiker
Preconditie	Parameters uit UM: Missend
Postconditie	Systeem: Parameters in UM opgeslagen Gebruiker: Vragenlijst ingevuld; Krijgt getailorde informatie te zien
Beschrijving Activiteit	1. Gebruiker opent pagina met getailorde informatie 2. Systeem registreert dat benodigde parameters voor tailoring missen in UM 3. Systeem toont passende vragenlijst aan Gebruiker 4. Gebruiker vult vragenlijst in 5. Systeem berekent parameter voor UM aan de hand van ingevulde vragenlijst 6. Systeem slaat parameter op in UM 7. Systeem tailored informatie op basis van parameter uit UM 8. Gebruiker leest getailorde informatie

UC004.0	**Probleem bepalen**
Doel	Gebruiker bevindt zich op persoonlijke pagina en wil weten welke factoren een rol spelen bij een hoge bloeddruk en aan welk probleem (welke factor, te weten beweging, gewicht, zout of drop) hij wil gaan werken
Actoren	Gebruiker
Preconditie	Systeem: Parameters uit UM (* = optioneel): Demografie; Aandoening; Risicoprofiel; BMI*; Voedselvoorkeuren*; Medicatie*; Cognitieve factoren* (bijv. Kennis, Opleidingsniveau, Need for Cognition); Dagelijkse Activiteit*; Mobiliteit* Ingevulde meetwaarden uit dagboek Gebruiker: Gebruiker weet dat hij het systeem wil gebruiken om zijn bloeddruk te controleren en verlagen Gebruiker kan meetwaarden ingevuld hebben
Postconditie	Systeem: Gevraagde parameters in UM opgeslagen; Probleem (factor) opgeslagen in Problem List; Systeem geeft gebruiker suggestie een doel te stellen voor het probleem (factor). Gebruiker: Gebruiker weet aan welk probleem (factor) hij wil gaan werken en deze in het systeem opgeslagen; gebruiker weet dat de volgende stap in het proces het stellen van een doel voor dit probleem is.
Beschrijving Activiteit	Via *Health Information*: 1. Gebruiker is op Persoonlijke Pagina en klikt op link naar algemene informatie (*Health Information*). 2. Systeem checkt of benodigde parameters uit UM bestaan. a. Ja? Ga door. b. Nee? Toon bericht dat gebruiker benodigde parameters uit UM moet invoeren en vragenlijst. 3. Gebruiker komt op beginpagina *Health Information* en krijgt algemene inleidende tekst over aandoening en wordt gevraagd waar hij meer over wil weten. Gebruiker heeft keuze uit a) veel gestelde vragen (FAQ); b) links naar specifieke informatie 4. Gebruiker klikt op link naar specifieke informatie (bijv. *Bloeddruk*). 5. Gebruiker krijgt pagina met specifieke informatie en maakt keus uit *Problemen* (bijv. minder zout) genoemd in tekst. 6. Gebruiker krijgt keus om probleem op te slaan in Problem List en a) verder te lezen; of b) een doel te stellen voor dit probleem via Goal Setting. 7. Gebruiker wordt doorgestuurd naar a) of b). Via *Problem* 1. Gebruiker is op Persoonlijke Pagina en klikt op *Problem* 2. Systeem checkt of benodigde parameters uit UM bestaan. a. Ja? Ga door. b. Nee? Toon bericht dat gebruiker benodigde parameters uit UM moet invoeren en vragenlijst. 3. Systeem checkt of er problemen op de Problem List staan. a. Ja? Toon dropdownlist met veel voorkomende problemen en daar onder de Problem List. b. Nee? Toon dropdownlist met veel voorkomende problemen en melding dat er geen problemen op Problem List staan. 4. Gebruiker krijgt *Problem* pagina te zien en kan keuze maken uit a) veel voorkomende problemen of b) naar *Health Information* om probleem te bepalen. 5. Gebruiker selecteert een van de veel voorkomende problemen en

	krijgt daarbij behorende achtergrondinformatie te zien. Gebruiker wordt gevraagd om te bevestigen of hij aan het geselecteerde probleem wil werken. 6. Gebruiker bevestigd geselecteerde probleem en krijgt suggestie om een doel te stellen voor het geselecteerde probleem. Via *Registreren & Monitoren* 1. Gebruiker is op Persoonlijke Pagina en klikt op *Registreren & Monitoren* 2. Systeem checkt of er meetwaarden ingevuld zijn. a. Ja? Ga naar 3. b. Nee? Geef melding dat er geen meetwaarden beschikbaar zijn. 3. Systeem laat pagina met ingevoerde meetwaarden in tabel (/grafiek) zien. 4. Gebruiker bepaalt aan de hand van meetwaarden welke factor probleem is en waar hij aan wil werken. 5. Gebruiker klikt op *Probleem* in menu of op pagina 6. Systeem checkt of er problemen op de Problem List staan. a. Ja? Toon dropdownlist met veel voorkomende problemen en daar onder de Problem List. b. Nee? Toon dropdownlist met veel voorkomende problemen en melding dat er geen problemen op Problem List staan. 7. Gebruiker krijgt *Problem* pagina te zien en kan keuze maken uit a) veel voorkomende problemen of b) naar *Health Information* om probleem te bepalen. 8. Gebruiker selecteert een van de veel voorkomende problemen en krijgt daarbij behorende achtergrondinformatie te zien. Gebruiker wordt gevraagd om te bevestigen of hij aan het geselecteerde probleem wil werken. 9. Gebruiker bevestigd geselecteerde probleem en krijgt suggestie om een doel te stellen voor het geselecteerde probleem.

UC005.0	**Doel stellen en plan maken**
Aanleiding	Gebruiker heeft zijn probleem bepaald en wil een doel stellen en een plan maken om het probleem aan te pakken.
Actoren	Gebruiker
Preconditie	Parameters uit UM: Aandoening; Cognitieve factoren (bijv. persoonlijkheid) Problem List: Geselecteerde Probleem (wanneer van toepassing) Plans List: Lijst met doelen en plannen (wanneer van toepassing)
Postconditie	Systeem: Doel en plan opgeslagen in Plans List; Parameters opgeslagen in UM (wanneer van toepassing) Gebruiker: Heeft een doel en een plan geformuleerd en kan metingen bij gaan houden via *Monitor*.
Beschrijving Activiteit	Via *Persoonlijke Pagina* (probleem niet ingevoerd): 1. Gebruiker is op Persoonlijke Pagina en klikt op *Doelen Stellen* in navigatie. 2. Systeem checkt of benodigde parameters uit UM bestaan. a. Ja? Ga door. b. Nee? Toon bericht dat gebruiker benodigde parameters uit UM moet invoeren. 3. Gebruiker komt op pagina *Doelen Stellen* met een aantal veel

	voorkomende doelen, de keus om zelf een doel te definiëren en eerder opgeslagen doelen (wanneer van toepassing). 4. Gebruiker selecteert een doel uit de veel voorkomende doelen 5. Gebruiker voert streefwaarde(s) en tijdsperiode in 6. Doel wordt opgeslagen in Plans List en gebruiker krijgt overzicht van het opgeslagen doel. Gebruiker kan keuze maken uit a) plan (subdoelen) opstellen of b) naar *Monitor*. 7. Gebruiker wordt doorgestuurd naar a) of b). Via *Persoonlijke Pagina* (probleem ingevoerd): 1. Gebruiker is op Persoonlijke Pagina en klikt op *Doelen Stellen* in navigatie. 2. Systeem checkt of benodigde parameters uit UM bestaan. a. Ja? Ga door. b. Nee? Toon bericht dat gebruiker benodigde parameters uit UM moet invoeren. 3. Systeem haalt problemen van Problems List 4. Gebruiker komt op pagina *Doelen Stellen* met informatie en advies aangaande zijn ingevoerde proble(e)m(en) en eerder opgeslagen doelen voor dat probleem (wanneer van toepassing). 5. Gebruiker voert streefwaarde(s) en tijdsperiode in 6. Doel wordt opgeslagen in Plans List en gebruiker krijgt overzicht van het opgeslagen doel. Gebruiker kan keuze maken uit a) plan (subdoelen) opstellen of b) naar *Monitor*. 7. Gebruiker wordt doorgestuurd naar a) of b). Via *Problem*: 1. Gebruiker heeft een Probleem geselecteerd en klikt op *Doelen Stellen* na bevestigen van probleem 2. Systeem checkt of benodigde parameters uit UM bestaan. a. Ja? Ga door. b. Nee? Toon bericht dat gebruiker benodigde parameters uit UM moet invoeren. 3. Systeem haalt problemen van Problems List 4. Gebruiker komt op pagina *Doelen Stellen* met informatie en advies aangaande zijn ingevoerde probleem en eerder opgeslagen doelen voor dat probleem (wanneer van toepassing). 5. Gebruiker voert streefwaarde(s) en tijdsperiode in 6. Doel wordt opgeslagen in Plans List en gebruiker krijgt overzicht van het opgeslagen doel. Gebruiker kan keuze maken uit a) plan (subdoelen) opstellen of b) naar *Monitor*. 7. Gebruiker wordt doorgestuurd naar a) of b).

UC006.0	**Zelfmetingen bij een doel invoeren**
Aanleiding	Gebruiker heeft een doel ingesteld en wil zelfmetingen bijhouden om voortgang ten opzichte van doel bij te houden
Actoren	Gebruiker
Preconditie	Parameters uit UM: Aandoening; Cognitieve factoren (bijv. persoonlijkheid) Plans List: Lijst met doelen en plannen
Postconditie	Systeem: Zelfmetingen opgeslagen in dagboek Gebruiker: Heeft zelfmetingen gedaan en ingevoerd in het systeem, kan deze metingen nu evalueren via *Feedback*.

Beschrijving Activiteit	Via *Persoonlijke Pagina* 1. Gebruiker is op Persoonlijke Pagina en selecteert *Metingen Invoeren* 2. Systeem haalt doelen van Plans List 3. Gebruiker komt op pagina *Metingen Invoeren,* hier staan zijn ingevoerde doelen 4. Gebruiker selecteert doel waarvoor hij zelfmetingen wil invoeren. 5. Systeem toont pagina met mogelijkheid de passende zelfmetingen bij doel in te voeren 6. Gebruiker voert meetwaarden in en selecteert *Opslaan* 7. Systeem slaat ingevoerde meetwaarden op in dagboek en gebruiker krijgt overzicht van opgeslagen meetwaarden. Gebruiker kan keuze maken voor a) terug naar Persoonlijke Pagina of b) Feedback/Evaluatie van doel 8. Gebruiker wordt doorgestuurd naar a) of b) Via *Doelen Stellen* 1. Gebruiker heeft doel gesteld en bevestigd, en selecteert *Metingen Invoeren* 2. Systeem haalt doelen van Plans List 3. Gebruiker komt op pagina *Metingen Invoeren,* hier staan zijn ingevoerde doelen 4. Gebruiker selecteert doel waarvoor hij zelfmetingen wil invoeren. 5. Systeem toont pagina met mogelijkheid de passende zelfmetingen bij doel in te voeren 6. Gebruiker voert meetwaarden in en selecteert *Opslaan* 7. Systeem slaat ingevoerde meetwaarden op in dagboek en gebruiker krijgt overzicht van opgeslagen meetwaarden. Gebruiker kan keuze maken voor a) terug naar Persoonlijke Pagina of b) Feedback/Evaluatie van doel 8. Gebruiker wordt doorgestuurd naar a) of b)

UC006.1	**Overzicht van zelfmetingen over bepaalde periode opvragen**
Aanleiding	Gebruiker heeft zelfmetingen bijgehouden en wil hier een overzicht van opvragen
Actoren	Gebruiker
Preconditie	Parameters uit UM: Aandoening; Cognitieve factoren Dagboek: Bevat zelfmetingen
Postconditie	Systeem: Overzicht van zelfmetingen gegenereerd; Advies samengesteld Gebruiker: Heeft overzicht van zelfmetingen ontvangen en kan hier een advies over opvragen of deze delen met zijn zorgverlener
Beschrijving Activiteit	Via *Persoonlijke Pagina* 1. Gebruiker is op Persoonlijke Pagina en selecteert *Metingen Bekijken* 2. Systeem haalt metingen op uit Dagboek 3. Gebruiker komt op pagina *Metingen Overzicht,* met een grafiek en/of tabel van de ingevoerde metingen en mogelijkheid tot selecteren van een bepaalde periode 4. Gebruiker selecteert periode waarvoor hij zelfmetingen wil bekijken. 5. Systeem toont pagina met een grafiek en/of tabel van de ingevoerde metingen over de geselecteerde periode met a) een link naar het gegenereerde advies en b) mogelijkheid tot delen met zorgverlener 6. Gebruiker selecteert a) of b)

UC007.0	**Feedback op zelfmetingen met betrekking tot een doel**
Aanleiding	Gebruiker heeft een doel ingevoerd en over een bepaalde periode zelfmetingen gedaan en ingevoerd en wil feedback op zijn voortgang met betrekking tot het doel
Actoren	Gebruiker
Preconditie	Parameters uit UM: Aandoening; Cognitieve factoren (bijv. Feedback Oriëntatie) Plans List: Bevat een doel en een plan om doel te bereiken Dagboek: Bevat zelfmetingen behorend bij het doel
Postconditie	Systeem: Overzicht van zelfmetingen gegenereerd; Feedback samengesteld Gebruiker: Heeft overzicht van zelfmetingen ontvangen; Heeft feedback op voortgang met betrekking tot doel ontvangen en kan deze delen met zijn zorgverlener
Beschrijving Activiteit	Via *Persoonlijke Pagina* 1. Gebruiker is op Persoonlijke Pagina en selecteert *Feedback* 2. Systeem haalt Doel op uit Plans List 3. Systeem haalt metingen behorend bij Doel op uit Dagboek 4. Systeem genereert feedback op basis van zelfmetingen en Feedback Oriëntatie 5. Gebruiker komt op pagina *Feedback*, met een overzicht van ingevoerde zelfmetingen behorend bij Doel in de vorm van een grafiek en/of tabel, en een advies passend bij de zelfmetingen en Feedback Oriëntatie 6. Gebruiker maakt keuze om advies al dan niet te delen met zorgverlener

C Strong Arguments and Affective Cues Stimuli

C.1 Strong Arguments

Waarom moet u minder zout gebruiken?

Van zout gaat de bloeddruk omhoog. Bij nieren die niet meer goed werken, is een goede bloed-druk belangrijk. De nierfunctie blijft dan langer stabiel.

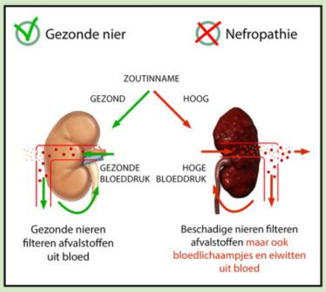
Wat is bloeddruk?
In ons lichaam pompt het hart het bloed door de aders. Dit geeft een bepaalde druk in de aders: de bloeddruk. Die bestaat uit twee getallen, bijvoorbeeld 130/80. Behandelaars zeggen ook wel: 130 over 80. Het eerste getal, 130, is de bovendruk: de druk in de vaten wanneer het hart zich samentrekt. Het tweede getal, 80, geeft aan hoe hoog de druk is als het hart zich ontspant.

Wat heeft bloeddruk met de werking van de nieren te maken?
Als de nieren minder goed werken, gaat de bloeddruk meestal omhoog. Het lichaam pompt het bloed met meer kracht door de bloedvaten. Er komt zo ook meer kracht op de vaatjes in de nieren. Het lichaam doet dit om het bloed beter te laten zuiveren. Keerzijde is dat de bloedvaatjes in de nier nog meer zullen beschadigen.

Bij een goede bloeddruk blijft de nierfunctie langer stabiel. Bij de behandeling van nierschade is het bereiken van een goede bloeddruk daarom heel erg belangrijk.

Wat heeft zout met hoge bloeddruk te maken?
Zout heeft direct invloed op de bloeddruk. Als u veel zout gebruikt, gaat de bloeddruk omhoog. Bij minder zout gaat de bloeddruk naar beneden. Als u per dag 3 gram zout minder gaat gebruiken, kan de bovendruk met 5 punten omlaag gaan en de onderdruk met 3. Als u nog minder zout gaat gebruiken, daalt de bloeddruk meestal nog meer.

Een voorbeeld:
Stel: uw bloeddruk is 140/90. Als u 3 gram zout minder gaat gebruiken, kan de bloeddruk dalen naar 135/87. Dit zijn gemiddelden. De bloeddruk kan bij u meer of minder dalen.



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Gebruik ík te veel zout?

Ja, er is een grote kans dat u te veel zout gebruikt. Negen van de tien mensen in Nederland gebruiken te veel zout: gemiddeld zo'n 9 gram per dag. De richtlijn voor gezonde voeding is maximaal 6 gram. De meeste mensen gebruiken dus 3 gram zout per dag te veel.

Waarom gebruiken we zoveel zout?
Zout is een smaakmaker. We voegen het toe aan ons eten om dat lekkerder te laten smaken. Verreweg het meeste zout krijgen we binnen zonder dat we het in de gaten hebben, tot wel 75% van de dagelijkse hoeveelheid zout. In alle voorverpakte en kant-en-klare producten zit zout. Er zit bijvoorbeeld zout in brood, broodbeleg, blikgroente, pakjes soep, koekjes, ijs en kant-en-klare maaltijden. In sommige van die producten zit heel veel zout (zie de voorbeelden hieronder).

Hier is veel winst te behalen. Als u voorverpakte en kant-en-klare producten vervangt door producten met minder zout of door verse producten, gebruikt u elke dag 3 tot 6 gram minder zout.

Dit is goed voor uw bloeddruk en daarmee voor de werking van uw nieren.

Voorbeelden:

1 volkorenboterham	0,44 gram zout
jam per boterham	0,01 gram zout
rookvlees per boterham	0,68 gram zout
2 blokjes belegen kaas	0,43 gram zout
250 ml maaltijdsoep uit blik	2,13 gram zout
350 gram pizza met vlees	5 gram zout
100 gram kipfilet	0,13 gram zout
2 stokjes saté met saus	1,51 gram zout

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Hoe kan ik minder zout gaan gebruiken?

Eetgewoontes veranderen is niet gemakkelijk. Uit allerlei onderzoeken is gebleken wat hierbij helpt. Dat bespreken we hieronder.
Er zijn twee manieren om minder zout te gaan gebruiken, een globale en een nauwkeurige. U kunt kiezen welke manier het beste bij u past. Als u heeft gekozen voor de globale manier en dit werkt niet genoeg, kunt u de precieze manier proberen.

De globale manier: voedingswaarde-informatie lezen en producten kiezen met weinig zout
Op bijna alle producten die u in de winkel koopt, staat een etiket met 'voedingswaarde-informatie'. Hierop staat onder andere hoeveel zout er in het product zit. Door deze etiketten te lezen, kunt u nagaan in waar veel en weinig zout in zit. In verse groente, fruit en vlees zit geen zout. In kant-en-klare maaltijden, pizza's, hartig broodbeleg en drop zit heel veel zout.

Soms staat de voedingsinformatie in zout aangegeven, soms in natrium. Is dit hetzelfde?
Nee, zout is niet hetzelfde als natrium. Met zout wordt keukenzout bedoeld. Dat bestaat uit twee delen: natrium en chloride. Natrium is lichter dan zout: 1 gram natrium = 2,5 gram zout.
De richtlijn voor gezonde voeding is 6 gram zout per dag, oftewel 2,4 gram natrium.
Staat er natrium op het voedingsetiket? Vermenigvuldig dit met 2,5 om het aantal grammen zout te krijgen.

U zult minder zout binnenkrijgen, als u producten met veel zout weglaat of vervangt door producten met minder zout. U kunt bijvoorbeeld:
- kant-en-klare producten schrappen
- zoutarme producten kopen
- met verse ingrediënten koken
- kruiden als smaakmaker gebruiken in plaats van zout

Als u minder zout binnen krijgt, zal uw bloeddruk lager worden. Dit is goed voor de werking van uw nieren.

PERISCOPE TNO innovation for life

Een voedingsdagboek bijhouden

Onderzoek bij mensen die willen afvallen, heeft aangetoond dat dit beter lukt als zij bijhouden hoeveel calorieën en vet zij op een dag eten. Minder zout gaan gebruiken zal ook beter lukken als u een 'voedingsdagboek' bijhoudt:

- Schrijf enkele dagen op wat u eet aan maaltijden en tussendoortjes.
- Schrijf bij elk voedingsmiddel op hoeveel zout erin zit. Dit staat op de verpakking van voorverpakte voedingsmiddelen en kant-en-klare producten. U kunt dit ook nazoeken op internet.

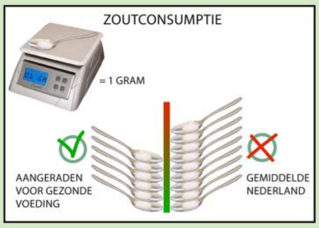
  Staat er natrium op het voedingsetiket? Vermenigvuldig dit met 2,5 om het aantal grammen zout te krijgen.

- Tel op hoeveel zout u gebruikt heeft.
- Deel dit door het aantal dagen dat u het dagboek heeft bijgehouden.

U weet nu hoeveel zout u gemiddeld op een dag gebruikt.

U kunt een voedingsdagboek bijhouden in een schrift, of bijvoorbeeld een website of app voor uw smartphone met voedingsdagboeken gebruiken.

Door het bijhouden van een voedingsdagboek krijgt u ook inzicht in uw eetgewoontes. Belegt u bijvoorbeeld uw boterhammen met erg zout beleg? Eet u vaak kant-en-klare maaltijden waar veel zout in zit? Kookt u wel met verse producten, maar eet u tussendoor veel drop of chips?



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Doelen stellen

Uit onderzoek onder mensen die willen afvallen is eveneens gebleken dat het stellen van een doel belangrijk is. De kans op succes is dan groter. Als u minder zout wilt gaan gebruiken, zal dat ook beter lukken als u met uzelf een doel afspreekt. Bijvoorbeeld: ik ga maximaal 6 gram zout per dag gebruiken. Het is nog beter als u uw doel lager stelt, bijvoorbeeld 5 of 4 gram zout per dag.

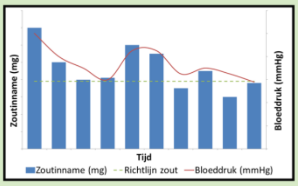
Hoe ga ik mijn doel bereiken?
Ga na hoe u uw zoutgebruik wilt verminderen. Dit kan aan de hand van uw voedingsdagboek en het inzicht in uw eetgewoontes. Welke producten gaat u minder gebruiken? Wat gaat u schrappen? Welke producten met veel zout gaat u vervangen, en waardoor?

Tips om minder zout te gebruiken:
- schrap kant-en-klare producten
- werk met zoutarme producten
- kook met verse ingrediënten
- gebruik kruiden als smaakmaker in plaats van zout

Haal ik mijn doel?
De beste manier om erachter te komen of u uw doel haalt, is weer het bijhouden van een voedingsdagboek. U weet zo precies hoeveel zout u binnenkrijgt en waar dat vandaan komt. Als u uw doel haalt en uw bloeddruk is goed, kunt u doorgaan op de ingeslagen weg.

Gebruikt ik nog te veel zout?
Ga in uw voedingsdagboek na hoe dit komt. Kunt u nog meer kant-en-klare producten vervangen of schrappen? Of kunt u nog meer verse groente en vlees gaan gebruiken?
Er kunnen ook andere redenen zijn voor het hoog blijven van de bloeddruk. U kunt dit met uw arts bespreken.

Heeft u vragen over hoe u minder zout kunt gaan gebruiken?
U kunt deze vragen stellen aan een diëtist, bijvoorbeeld in het ziekenhuis waar u onder behandeling bent.



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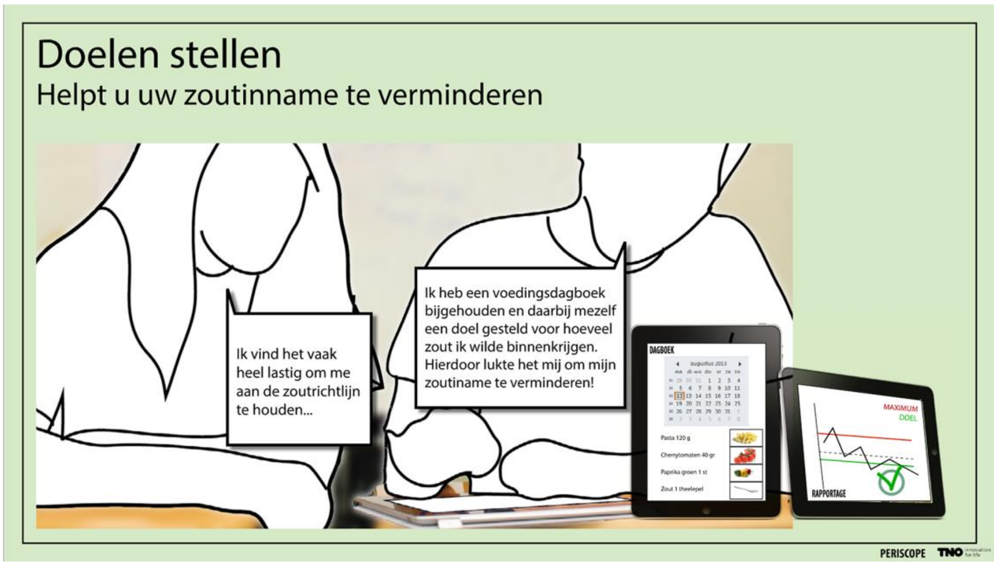
C.2 Affective Cues


Hoe kan ik minder zout gaan gebruiken?
Verse en zelfbereide voedingsmiddelen
Voorverpakte of voorbewerkte voedingsmiddelen
Door voorverpakte en kant-en-klare producten te vervangen door verse of zoutarme producten, gebruikt u elke dag 3 tot 6 gram minder zout.
Driekwart van de dagelijkse zoutconsumptie komt namelijk ongemerkt binnen via voorbewerkte producten.
Dr. Joris Groenhouten
Internist-nefroloog
PERISCOPE TNO


Voedingswaarde-informatie zegt iets over zout
Lees daarom de informatie op de verpakking
Voedingswaarde per 100 ml:
Energie 1196kj (286Kcal)
Eiwit 0.8g
Koolhydraten 13.3g
waarvan suikers 10.8g
Vet 25.8g
waarvan verzadigd 2.0g
enkelvoudig onverzadigd 15.8g
meervoudig onverzadigd 7.0g
Voedingsvezel 0.3g
NATRIUM 1.0g
Een eetlepel bevat 43 kcal.
1 gram natrium = 2,5 gram zout
Als op de verpakking natrium staat, dan vermenigvuldig ik dat met 2,5 om het aantal gram zout te weten. 1 gram natrium is dus 2,5 gram zout!
PERISCOPE TNO


Een voedingsdagboek bijhouden geeft inzicht in zout
Bijvoorbeeld terwijl u kookt
vandaag maandag 27 aug
70 gram
3 hele tomaten
1 gele, 1 groene paprika
1 theelepel zout
INVOER
RAPPORTAGE
DAGBOEK
PERISCOPE
TNO


Doelen stellen
Helpt u uw zoutinname te verminderen
Ik vind het vaak heel lastig om me aan de zoutrichtlijn te houden...
Ik heb een voedingsdagboek bijgehouden en daarbij mezelf een doel gesteld voor hoeveel zout ik wilde binnenkrijgen. Hierdoor lukte het mij om mijn zoutinname te verminderen!
DAGBOEK
MAXIMUM
DOEL
RAPPORTAGE
PERISCOPE
TNO

D Questionnaires Feasibility Study

D.1 Education

Based on Standaard Onderwijsindeling (Statistics Netherlands, 2011).

Wat is uw hoogst genoten opleiding?

O Basisonderwijs

O VBO / MAVO / VMBO

O MBO / HAVO / VWO

O HBO / Bachelor

O WO / Master

D.2 Kidney Disease Knowledge Questionnaire

Dutch translation, based on Wright et al. (2011). Contains 29 multiple choice items that measure general knowledge about kidney disease, kidney functions and symptoms of kidney disease. Right answers score 1 point, wrong answers score 0 points. Asterisks denote right answers.

Items about general knowledge

Uw bloeddruk zou gemiddeld … moeten zijn

O 160/90

O 150/100

O 170/80

O Lager dan 130/80 *

Zijn er medicijnen die uw arts kan voorschrijven om uw nieren zo gezond mogelijk te houden?

O Ja *

O Nee

Waarom is teveel eiwit in de urine niet goed voor de nieren?

O Het kan de nieren beschadigen

O Het is een signaal dat de nieren beschadigd zijn

O Het is een signaal dat de nieren beschadigd zijn EN het kan de nieren beschadigen *

O Het kan een infectie in de urine veroorzaken

O Alle antwoorden zijn goed

Selecteer ÉÉN MEDICIJN in onderstaande lijst welke personen met een CHRONISCHE nieraandoening zouden moeten VERMIJDEN

O Lisinopril

O Tylenol

O Ibuprofen *

O Vitamine E

O IJzer-pillen

Behandeling van nierfalen zou kunnen gebeuren door… (U kunt MAXIMAAL TWEE ANTWOORDEN selecteren voor deze vraag)

O Long biopsie

O Hemodialyse *

O Bronchoscopie

O Colonscopie

O Niertransplantatie *

Wat betekent “GFR”?

O Glomerulaire filtratiesnelheid – een maat voor de nierfunctie *

O Globaal filtratie resultaat – de hoeveelheid afvalstoffen die de nieren uit het bloed gefilterd hebben

O Glucosefilterrestant – de hoeveelheid glucose die resteert in het bloed na filtering in de nieren

O Glomerulaire faalratio – een maat voor nierschade

Zijn er verschillende stadia van CHRONISCHE nieraandoeningen?

O Ja *

O Nee

Heeft iemand met een CHRONISCHE nieraandoening een grotere kans op een hartaanval?

O Ja *

O Nee

Heeft iemand met een CHRONISCHE nieraandoening een grotere kans op overlijden?

O Ja *

O Nee

Items about kidney functions

De onderstaande vragen gaan over WAT DE NIEREN DOEN. Geef aan welke functies de nieren volgens u vervullen.

	JA	NEE
Maken de nieren urine?	*	
Zuiveren de nieren uw bloed?	*	
Helpen de nieren om uw botten gezond te houden?	*	
Helpen de nieren haaruitval tegen te gaan?		*
Houden de nieren het gehalte rode bloedlichaampjes in het bloed op peil?	*	
Helpen de nieren uw bloeddruk op peil te houden?	*	
Helpen de nieren uw bloedsuikerspiegel op peil te houden?		*
Helpen de nieren het gehalte kalium in het bloed op peil te houden?	*	
Helpen de nieren het gehalte fosfor in het bloed op peil te houden?	*	

Items about symptoms

De onderstaande vragen gaan over SYMPTOMEN. Geef aan of iemand met een chronische nieraandoening of nierfalen onderstaande symptomen kan hebben.

	JA	NEE
Vermoeidheid	*	
Benauwdheid	*	
Metaalsmaak / vervelende smaak in de mond	*	
Ongebruikelijke jeuk	*	
Misselijkheid / braken	*	
Haaruitval		*
Slaapproblemen	*	
Gewichtsverlies	*	
Verwarring	*	
Helemaal geen symptomen	*	

D.3 Need for Cognition Scale

Dutch translation by Pieters et al. (1987). Items are scored on a 9-point Likert Scale, ranging from ‘Helemaal niet mee eens’ (score -4) to ‘Helemaal mee eens’ (score +4). An asterisk denotes items that are reverse scored.

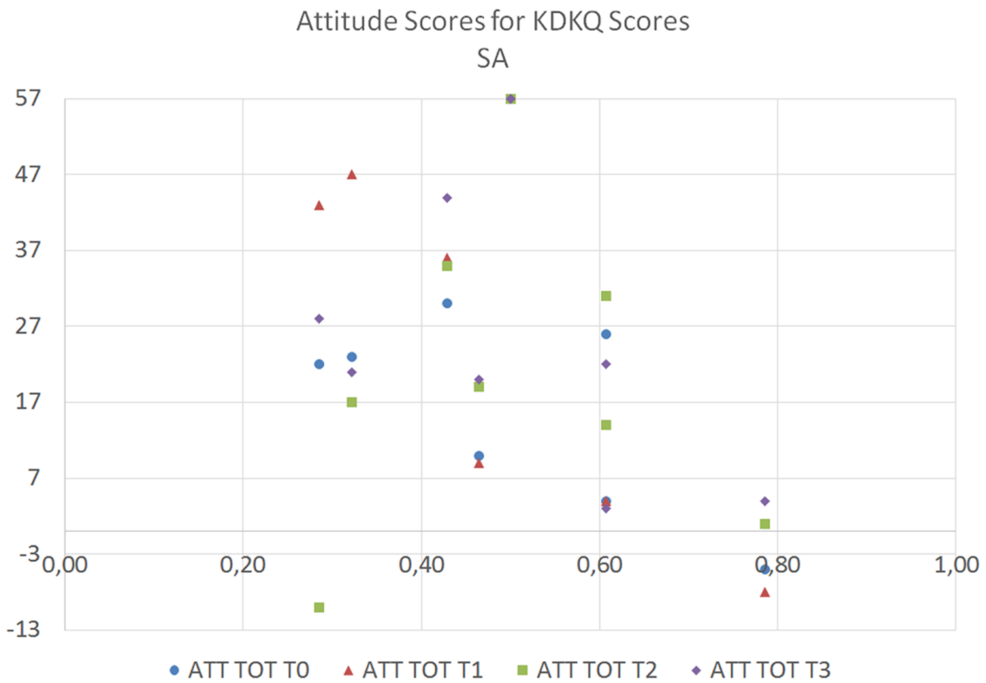
1. Als ik moet kiezen heb ik liever een ingewikkeld dan een simpel probleem
2. Ik ben graag verantwoordelijk voor een situatie waarin veel nagedacht moet worden
3. Nadenken is niet iets wat ik doe voor mijn plezier*
4. Ik doe liever iets waarbij weinig nagedacht hoeft te worden, dan iets waarbij mijn denkvermogen zeker op de proef wordt gesteld*
5. Ik probeer situaties the vermijden waarin de kans groot is dat ik diep over iets moet nadenken*
6. Iets langdurig en nauwgezet afwegen geeft mij voldoening
7. Ik denk alleen zo veel als nodig is*
8. Ik denk liever na over kleine dagelijkse dingen dan over lange-termijn zaken*
9. Ik hou van taken waarbij weinig nagedacht hoeft te worden als ik ze eenmaal geleerd heb*
10. Het idee dat je op je verstand moet vertrouwen om de top te bereiken spreekt mij aan
11. Ik geniet echt van een taak waarbij je met nieuwe oplossingen voor problemen moet komen
12. Het leren van nieuwe manieren om te denken vind ik niet echt boeiend*
13. Ik vind het prettig als mijn leven gevuld is met puzzels die ik moet oplossen
14. Abstract denken is een bezigheid die mij aanspreekt
15. Ik heb liever een taak die intellectueel, moeilijk en belangrijk is, dan een taak die enigszins belangrijk is, maar waarbij je niet veel hoeft na te denken
16. Als ik een taak heb voltooid die veel mentale inspanning heeft gevergd ben ik eerder opgelucht dan voldaan*
17. Ik vind het voldoende wanneer iets blijkt te werken: hoe of waarom het precies werkt interesseert me niet*
18. Gewoonlijk denk ik uitgebreid na over zaken, zelfs wanneer ze mij niet persoonlijk aangaan

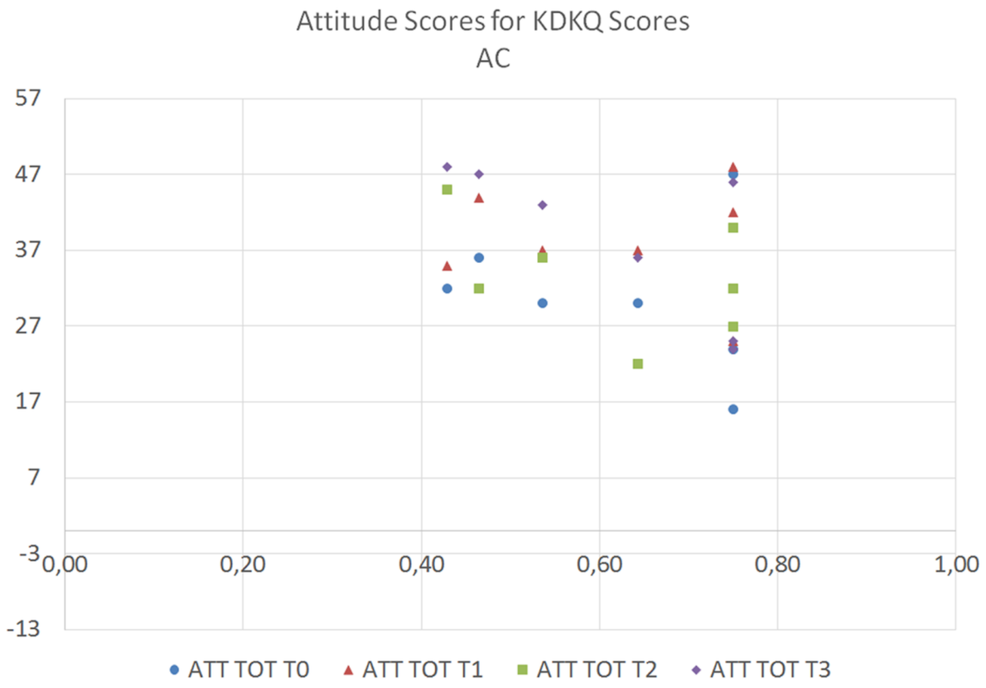
E Distribution Plots

E.1 Knowledge

The X-axis represents the score on the KDKQ: percentage of answers correct (range 0% – 100%).

In the SA condition, if we neglect the outlier, we see a negative trend. Participants that have a higher knowledge, have lower attitude scores on all Ts. This is not what we would expect: when people have more knowledge about a subject, they have a higher ability to elaborate on information and should consequently prefer SA messages. In the AC condition, however, there is no clear trend between attitude score and score on KDKQ.

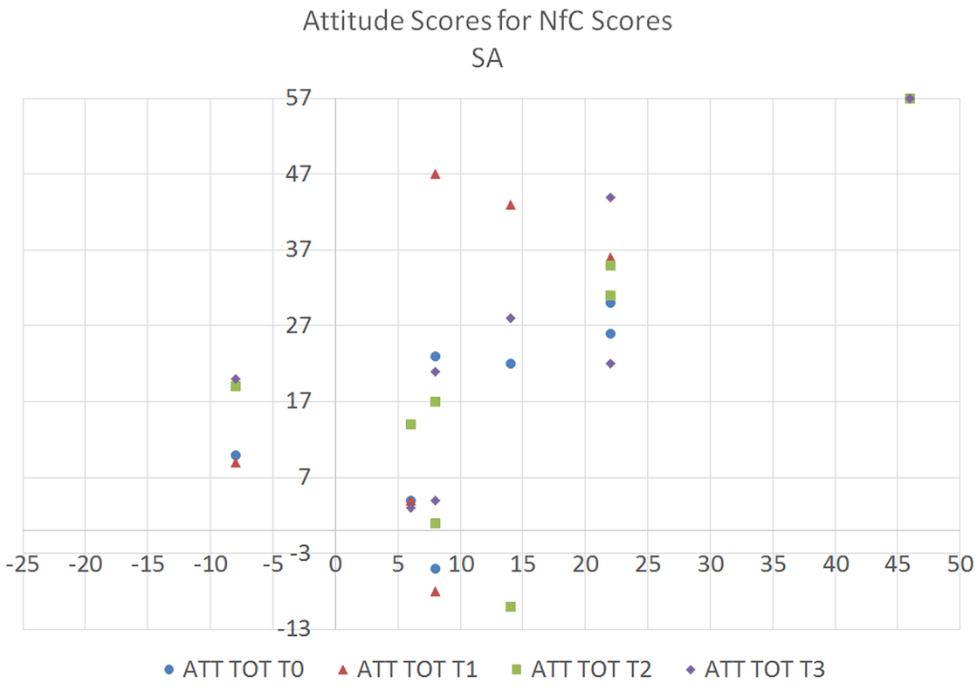


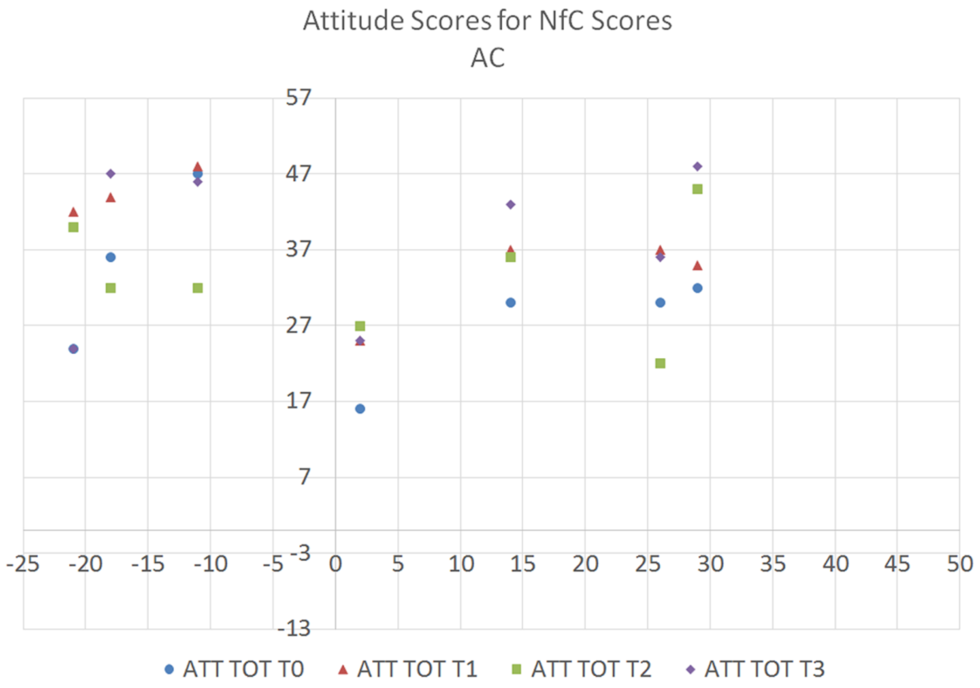


E.2 Need for Cognition

The X-axis represents the NfC score (range -72 – +72).

In the SA condition, if we neglect the outlier, we see that participants with a higher Need for Cognition have a more positive attitude, but only for the extremes (negative Need for Cognition and >20 Need for Cognition). This is what we would expect: people with a higher Need for Cognition are more inclined to elaborate on information and thus more susceptible for strong arguments. However, participants with an average Need for Cognition score do not show this relation. In the AC condition, there is no clear trend between attitude score and NfC score.


Attitude Scores for NfC Scores
SA
ATT TOT T0
ATT TOT T1
ATT TOT T2
ATT TOT T3


Attitude Scores for NfC Scores
AC
ATT TOT T0
ATT TOT T1
ATT TOT T2
ATT TOT T3